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Mobility as a Service (MaaS) as an instrument for transport policy.

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AFFIDAVIT

I, **Mike Wengler**, hereby declare

1.That I am the sole Author of the present Master Thesis "**Mobility as a Service (MaaS) as an instrument for transport policy"**, 90 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

2.That I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

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ABSTRACT ENGLISH

As more and more people live in urban areas, cities are affected by the negative impacts of the rapidly increasing car traffic, which is consequently leading to rising traffic problems and capacity bottlenecks. These challenges are also being complicated by increasing traffic emissions, falling of air quality and noise disturbance. Since the creation of additional infrastructures will not solve the urban traffic problems, decision-makers are looking for new resolutions to tackle these issues with new mobility options. The key challenge is to develop a global mobility policy which could help reducing the high impact on people, the environment and increasing the efficiency of transport systems and infrastructure. The main focus will be on reducing the usage of private vehicles and promoting a greater use of public transport and other alternative transport modes.

New challenges affecting the planning and the development of mobility are very present, as steady growth, urbanization, demographic changes, value changes in society, scarcity of resources, and the need to reduce emissions will have us rethinking our forms of mobility. However, new social trends and important technological advances will radically change and shape the demands and possibilities of mobility in our society.

Mobility as a Service (MaaS) is one of the most innovative approaches tackling transport policy challenges in order to complete a more efficient design and provision of mobility and transport infrastructures. The main idea is to provide an integrated mobility service based on dynamic data and consumer-defined travel preferences, combining the combination of all means of transport in one single product for the designated users. With MaaS, Mobility is provided as a seamless door-to-door service, where users pay mobility services rather than investing in their own vehicles. It is likely that this trend will change the mobility behavior of society, especially in densely populated areas.

As MaaS offers an innovative mobility solution, it is expected to have the potential to contribute to a reduction of the use of private vehicles, to an increase of the efficiency of infrastructure and transport systems and to minimize the negative effects of the car-fixation, such as GHG-Emissions, noise or extensive land use.

The aim of the thesis is to investigate the potential impacts that Mobility as a Service (MaaS) will have on the goals and objectives of transport policy. Thus, it is intended to provide an insight into the extent to which MaaS can offer a sustainable solution to deal with traffic issues and environmental impacts as well as to increase the efficiency of transport capacities. Therefore, the ideas and the specific characteristics of the MaaS Concept, as well as the most important changes that will result through MaaS in the transport sector will be pointed out. Finally, the expected effects and impacts of MaaS are specified and used to develop a set of indicators that can be applied to further investigate the significance of MaaS as an instrument to achieve goals and objectives of transport policy.

ABSTRACT GERMAN

Immer mehr Städte leiden zunehmend unter den negativen Auswirkungen des rasant wachsenden Autoverkehrs und den daraus resultierenden Verkehrsproblemen, Emissionen sowie der stetigen Lärmbelästigung. Entscheidungsträger suchen daher nach neuen Ansätzen, um mit neuen Mobilitätslösungen eine nachhaltigere Verkehrspolitik zu gestalten. Ziel ist es muss es sein, eine globale Mobilitätspolitik zu entwickeln, die dazu beiträgt, die negativen Auswirkungen des Verkehrs auf Mensch und Umwelt zu reduzieren die Effizienz der Verkehrssysteme und der Infrastruktur zu erhöhen. Der Schwerpunkt liegt auf der Reduzierung des privaten Autoverkehrs und der Förderung einer stärkeren Nutzung des öffentlichen Verkehrs sowie anderer alternativer Verkehrsträger.

Die Realität, dass neue Herausforderungen die Planung und die Entwicklung der Mobilität beeinflussen, ist bereits sehr präsent, da stetiges Wachstum, Urbanisierung, demographische Veränderungen, Wertveränderungen in der Gesellschaft, Ressourcenknappheit und die Notwendigkeit, Emissionen zu reduzieren, uns zwingen wird, unsere Mobilität zu überdenken. Dabei werden neue soziale Trends wie die Sharing Economy und technologische Fortschritte werden die Anforderungen und Möglichkeiten der Mobilität in unserer Gesellschaft radikal verändern und prägen.

Mobility as a Service (Mobility as Service, MaaS) gilt als einer der innovativsten Ansätze zur Bewältigung verkehrspolitischer Herausforderungen für die effizientere Gestaltung und Bereitstellung von Mobilitäts- und Verkehrsinfrastrukturen. Die Idee besteht darin, einen integrierten Mobilitätsdienst zu schaffen, der auf der Nutzung dynamischer Daten und Reisepräferenzen basiert und die Kombination aller Transportmittel in einem einzigen Angebot kombiniert. Mit MaaS wird Mobility als nahtloser Door-to-Door-Service zur Verfügung gestellt, in dem die Nutzer Mobilitätsdienste in Anspruch nehmen.

Da MaaS eine innovative Mobilitätslösung darstellt, soll das Potenzial zur Reduzierung der Nutzung von Privatfahrzeugen, zur Steigerung der Effizienz von Infrastruktur- und Transportsystemen und zur Minimierung der negativen Auswirkungen des Verkehrs untersucht werden. Ziel der Arbeit ist es, die potenziellen Auswirkungen, die MaaS für die Ziele der Verkehrspolitik haben wird, zu untersuchen. Es soll ein Einblick entstehen, inwiefern MaaS eine nachhaltige Lösung zur Bewältigung von Verkehrsproblemen und Umweltauswirkungen sowie zur Steigerung der Effizienz der Transportsysteme bieten kann. Dazu werden zunächst die Ideen und Besonderheiten des MaaS-Konzepts sowie die wichtigsten Veränderungen, die sich durch MaaS im Verkehrssektor entstehen, beschrieben. Anschließend werden die erwarteten Effekte und Auswirkungen von MaaS spezifiziert. Durch Anwendung von Indikatoren soll es möglich sein, die Bedeutung von MaaS als Instrument zur Erreichung der Ziele der Verkehrspolitik näher zu untersuchen.

1. INTRODUCTION

1.1 Context

Mobility is a basic necessity and has an enormous importance for our society - it stands for movement, freedom and the possibility to get quickly from one place to another. Since the beginning of the 19th century, our society has been characterized by a steady increase in mobility and simultaneous acceleration. (Funke et al., n.pag.)

Mobility forms the basis of our life and business, enabling movement, change and transformation, individually as well as socially. This entails risks and uncertainties, but also offers new opportunities, a greater variety of options and the possibility to learn new things. In the future, it can be assumed that the demand for mobility and the demand for mobility due to further growing cities and a rapidly advancing globalization will grow significantly. (Zukunftsinstitut 2016-1, n.pag.)

The Automobile is one of the main key drivers of mobility. The present transport system is shaped by individual mobility and the number of motor vehicles is rapidly growing, in connection with population growth and economic growth. Over the last 50 years, the world's motor vehicle stock has grown quickly. Even if calculating the total number of motor vehicles on the planet is an inexact science, it is estimated that the total crossed 1 billion vehicles sometime during 2010. Further, by other estimates, the total number of vehicles worldwide could double up to 2.5 billion by 2050. (Green Car Report 2017, n.pag.) This dominance of the automobile results primarily from the need for individual movement, by allowing people to reach their destination at any time and relatively reliably. (Zukunftsinstitut 2016-4, n.pag.)

This freedom of mobility is, however, at a price, since everyday urban life often looks quite different. Once the car was used as an "enabler" of mobility, blocked streets and overcrowded city centers, the car today appears rather as a "preventer" of mobility. (Funke et al., n.pag.) The car fixation leads to an overloading of the traffic infrastructure and to daily traffic impairments, especially in urban regions, which makes the car always more inefficient when it comes to moving around cities. It often seems to be much more pleasant not to start at all because it is impossible to escape the inevitable traffic jam around the destinations or the mobility costs including parking exceed the total value of the trip. (Zukunftsinstitut 2016-6, n.pag.)

The costs for people and the environment also increase. The growing traffic leads to traffic jams, accidents and noise. Furthermore it has a higher environmental impact, such as the sealing of large areas or CO2 emissions. (Flügge 2016, p.92) In addition, noise and fine dust pollution, particularly in metropolitan areas, affect environmental quality. (Funke et al., n.pag.)

In addition, there are considerable lacks in the accessibility of certain areas, especially by the problem of the first and last mile. Over the past decades, these problems have increasingly worsened in many regions, as large infrastructure projects to accelerate and expand transport capacities have always been preferred to regional expansion. Large distances and poor

accessibility subsequently also lead to a migration to the cities and thus to shrinking municipalities. (Zukunftsinstitut 2016-6, n.pag.)

Today´s society faces the development of a new mobility culture. The use of mobility, as we have experienced and practiced it for decades, is currently witnessing a historical break. Before us lies the beginning of a new, multi mobile era. The fact that the conditions and concepts for mobility change with time passing by, is nothing unusual in itself. As early as the last century, technological progress and social change in values led to a change in the framework for mobility.

Society in the 21st century is characterized not only by a further growing need for mobility, but also by an increasing variety of forms of mobility. Whether it is professional commuting, school trips, family and doctor visits, shopping and leisure activities, holiday and business travel, smartphones and tablets, mobile internet, video and telephone conferences, we are always, everywhere and at the same time traveling to more places than ever before. (Zukunftsinstitut 2016-4, n.pag.)

With the growth and development of cities and society, the needs and demand of mobility are changing in the same way people move. However, as the demand for mobility continues to increase, the future will not necessarily be faster. In the future, it will not anymore be the maximum speed that determines the mobility of our society, but the way people move forward, as we actually get "the best". (Zukunftsinstitut 2016-4, n.pag.)

This includes changing the basic attitude towards mobility and developing an increasing variety of forms of mobility. Although it can be assumed that the car probably cannot be completely waived in the long term, the choice of means of transport will be strongly shifted by the increasing attractiveness of alternative mobility solutions by public transport, not least in favor of public transport, cycling and walking. Especially in the cities, an increasing number of alternative means of transport will be covered. More and more people refuse to own their own car and are more likely to resort to an alternative offer, such as car-sharing, which allows them the flexible use of a car, when and where they actually need it. (Zukunftsinstitut 2016-6, n.pag.)

At the same time, mobility will increasingly be understood as a door-to-door service, which is offered as a seamless mobility solution from the own doorstep to the destination. Many travelers do not want to lose any senseless time when they arrive and depart, wait for connections and change their means of transport, or spontaneously change the destinations according to individual preferences. The integration of the first and last mile, the connection to mobility nodes and traffic networks of public transport networks, which has so far often been neglected and always taken into account by the traveler himself, plays a decisive role. (Zukunftsinstitut 2016-6, n.pag.)

These changes in the mobility behavior will create new usage habits and the importance of intermodal and multimodal road chains in the future, which will allow public and individual transport to be selected and combined in a much more demand-oriented, more diverse and spontaneous manner. (Zukunftsinstitut 2012-1, n.pag.)

Due to the enormous influence of different developments, such as the constant urbanization and the constantly growing demand for mobility, cities and municipalities are increasingly faced with the inevitable socioeconomic, logistical and ecological challenges in the development of transport systems. (UITP 2011, p.1) Mobility concepts are increasingly rarely meeting mobility requirements and are increasingly reaching their limits by new challenges to the provision of infrastructure and transport systems. People's needs to move efficiently in cities can often no longer meet current mobility concepts. (Funke et al., N.PAG.)

As more and more cities are affected by the negative impact of the rapidly increasing car traffic - whether due to clogging, noise or exhaust fumes - and that this problem is likely to worsen, decision-makers worldwide are looking for new solutions to tackle and solve these problems. Municipalities and traffic planners are clearly narrowed down in this respect, as the provision of new infrastructures and capacities is often slow and expensive. A simple addition of supplementary roads and car parks or buses and trains is often not directly feasible, and will not be able to solve all problems of the congested inner city areas. In addition, many cities are constrained by financial bottlenecks. As more and more people live in urban areas, the creation of additional infrastructures will not solve the urban traffic problems. (Goddall et al., 2017, n.pag.) In order to overcome these bottlenecks and create a more efficient transport system, innovative, sustainable and significantly more efficient transport solutions are required.

While the problem of local emissions can be solved by means of purely technical solutions, i.e. alternative drives, these are not suitable for the problem of overfilled roads. Sustainable technologies such as electro-mobility take on the changing mobility needs but cannot solve mobility problems alone. Also a "green" jam and causes the same traffic and space problems as conventional cars. (Fraunhofer-Institut für System- und Innovationsforschung o.a, n.pag.) Rather, it will be necessary to explore new ways of planning and providing urban infrastructure and mobility opportunities.

The goal must be to relieve urban structures and to develop approaches that take account of changes in mobility behavior. New social trends as well as developments in information and communication technology are creating tremendous potential for the future-oriented further development of transport concepts. There are new opportunities for the implementation of a new transport policy paradigm to lead to a sustainable change in the transport sector. (Russ, Tausz 2015, n.pag. & Deffner et al., 2014, p.204 & Zukunftsinstitut 2016-6, n.pag.)

There is already a tendency to recognize that citizens are reacting to urban traffic problems and already combining several means of transport. This is due in particular to the technological developments that make mobility more flexible and uncomplicated. These can be tailored and offered much more efficiently to the needs and preferences of the customer. Through the networking of means of transport and services, it will be possible to purchase mobility faster, more flexible and autonomous, and in a manner that is in accordance with needs, without necessarily having to resort to a car of its own. This is increasingly the result of a trend towards using mobility as a service and decoupling it from vehicle ownership. (Schwarzer 2010, n.pag. & Zukunftsinstitut 2016-6, n.pag.)

The tendency to stray away from vehicle ownership to a multimodal mobility culture can be viewed as an important factor and pioneer for a more sustainable design of individual mobility as well as a future-oriented development of cities. The changes open up freedom degrees for the use of new multimodal transport services and a change in environmentally friendly traffic behavior. (Deffner et al., 2014, p.205) Future strategies and mobility concepts should be addressed here, highlighting the attractiveness and efficiency of a multimodal approach. (Fraunhofer-Institut für System- und Innovationsforschung o.a, n.pag.)

For a long time, it seemed as difficult to convey its multimodality and use of alternative means of transport in the transport policy and the public, not least because of the bad image of public transport. The pressure of action, both climate protection and economic constraints, but also by the technological developments mentioned, is now changing. (Deffner et al., 2014, p.203)

The key challenge is not to achieve less mobility, but to make mobility much more intelligent and efficient. Therefore, mobility must not be viewed independently, but must be perceived as an integrated system, with different strengths and objectives that complement each other and enable the customer to achieve a seamless door-to-door planning. Today, multimodal mobility is one of the main keys to a more sustainable transport system. The promotion of multimodal transport systems is the subject of various transport policy strategies to increase the overall efficiency of transport systems and to achieve spatial and environmental objectives. (Deffner et al., 2014, p.203)

The main focus in terms of mobility and space distribution will therefore be to reducing the use of private vehicles and on promoting greater use of public transport and other alternative means of transport. To this end, it should be taken into account that the emotional aspect of the ownership of private vehicles and, in particular, the associated fixed costs of ownership, will make it possible for owners to travel every direction by car. The objective must thus be to change citizens' mobility behavior and provide a genuine alternative to the private vehicle. (Fraunhofer-Institut für System- und Innovationsforschung o.a, n.pag.)

To achieve this, transport policy must address the increasing demands on spontaneous and flexible mobility solutions and respond with appropriate offers for cross-linked, intermodal mobility. It is to be assumed that new, holistic mobility concepts, which are characterized by inter- and multimodality as well as sharing forms and which link all forms of movement, will therefore gain enormously in importance. (Deffner et al., 2014, p.203)

Seamless mobility is one of the most significant changes in the mobility culture, and it is likely that this trend will change the mobility behavior of society, especially in densely populated areas. Mobility is offered and provided mainly as a door-to-door service. This will also include new, alternative means of transport that are available on-demand. This opens up new, cheap and flexible opportunities for individual mobility, and the boundaries between private and public transport will change in the long term and will be perceived far more inaccurately. (Hannon et al., 2016, n.pag.)

The key to fostering such a more sustainable mobility culture is to build a strategic cross-traffic cooperation with combined mobility services such as taxis, bicycles and car-sharing services, and create a more complete offer for customers and provide lifestyle services. (UITP 2011, p.1) Individual transport must no longer be in competition with each other, but must be linked together intelligently and innovatively through a combined use. (Zukunftsinstitut 2016-6, n.pag.) Only such a combined mobility offer can compete with the private vehicle with regard to flexibility, comfort and cost structure. (UITP 2011, p.1)

1.2 Problem Definition

The reality that new challenges affect the planning and the development of mobility is already very present. New social trends and important technological advances will radically change and shape the demands and possibilities of mobility in our society. (Hannon et al. 2016, n.pag.) The mobility of the future, as well as its economic, social and environmental impact, can therefore be seen as one of the most stubborn challenges faced by cities around the world. The urban areas are already confronted with increasing capacity bottlenecks in terms of infrastructure and financial resources and their possibilities are severely limited. These challenges are also made more difficult by increasing traffic emissions, air quality and noise pollution.

The provision of infrastructure and transport systems is of fundamental importance for mobility. However, many cities are already, however, at a point where an additional provision can hardly serve as an efficient means to meet the demand. (Buscher et al., P.11) For most cities, the creation of additional street space and the provision of more vehicle use is no longer a solution, either because of the constraints imposed by spatial conditions or by scarce public funds.

In addition, demand for mobility and the need for mobility will continue to rise in the future. Trends such as steady growth, urbanization, demographic change, fundamental value change in society, scarcity of resources, and the need to reduce emissions will force us to rethink our forms of mobility and find new solutions. The key challenge is therefore to implement a global mobility policy which will help to reduce the high impact on people, the environment and the health of transport. The optimization of transport planning, the efficient use of existing infrastructure and the improvement of transport networks are therefore fundamental principles for the future of transport policy in order to meet the needs of different beneficiary groups in the future. (UITP 2016, p.2)

To this end, the transport policy must set specific incentives and framework conditions to ensure a more environmentally compatible mobility. (Verkehrsclub Deutschland 2013, n.pag.) It is necessary to counter these challenges and to develop new ways and approaches to counteract the negative effects and effects of motor vehicle occupancy and traffic, while at the same time meaningfully developing mobility. (UITP 2011, p. 1) This is an important step in the search for new ways to implement mobility requirements and wishes economically, comfortably and sustainably. (Zukunftsinstitut 2016-1, n.pag.)

Mobility as a Service (Mobility as Service, MaaS) is one of the most innovative approaches to tackling transport policy challenges for the more efficient design and provision of mobility and transport infrastructures. MaaS offers a time- and cost-efficient as well as seamless transport solution that opens up the challenges of urban and traffic planning and the mobility of the future. The idea is to provide a single integrated mobility service based on dynamic data and consumer-defined travel preferences, combining the combination of physical transport modes such as buses, trains, taxis, bicycles, and cars to the user in a single product. MaaS stands for a transition in mobility where users pay mobility services rather than investing in their own vehicles.

The expected, potential outputs and effects that may result from the implementation of MaaS provide a possible response to the most pressing questions as to how urban residents will shape individual mobility in the future and which means of transport will be chosen. MaaS promises an innovative mobility solution which, on the one hand, is intended to provide a transport system which is able to meet the increasing demand of urban residents to have access to urban services at any time. On the other hand, the approach of understanding mobility as an integrated multimodal approach is intended to significantly reduce the need to use private vehicles while minimizing the negative effects and impacts of the car-fixed society as well as the associated externalities. (Flügge 2016, p.92)

In addition, MaaS will help to offer mobility much more cost-effectively and thus make it more affordable, which should also lead to a reduction in private car ownership. In addition, the concept has the potential, inter alia to increase the efficiency of transport and to reduce greenhouse gas emissions by modifying mobility behavior.

1.3 Research Objectives

Mobility as a Service is therefore a potential answer to the question of how to meet the transport policy challenges for a future-oriented and sustainable development of transport systems and the growing demand for flexible access to mobility. Therefore, it is intended to illustrate the impacts of Mobility as a Service for transport policy. To this End, the following subject of this thesis and research questions has been chosen:

Mobility as a Service (MaaS) as an Instrument for Transport Policy

- What are the major challenges for transport policy, and what are the trends to consider?
- How will Mobility as a Service affect the transport sector and how will the transport sector change in the future?
- Which transport policy goals are pursued with the development of Mobility as a Service, and to what extent does MaaS contribute to the achievement of these transport policy objectives?

The aim of the work is therefore to investigate the importance of the mobility as a service concept for the transport policy goals of an environmentally compatible and sustainable

design of mobility concepts. It is intended to provide an insight into the extent to which MaaS can offer a sustainable solution to tackle traffic issues and environmental impacts as well as to increase the efficiency of transport capacities.

To this end, the basic ideas and visions of the MaaS concept are to be examined and the essential, specific characteristics of Mobility as a Service are described. Furthermore, the influence of MaaS on the mobility of the future and the extent to which the concept changes the structural prerequisites of the transport sector should be clarified. With the aim of further deepening MaaS' importance in terms of transport policy, the definition of transport policy objectives that can be linked to Maas and a description of the essential elements of the concept are to be carried out. The objectives as well as the core elements of MaaS serve as a description and evaluation basis for a case study in which the most innovative MaaS concepts are currently being described and their contribution to the achievement of transport policy objectives.

1.4 Methodical approach

Since MaaS itself is a relatively new and innovative approach, it will be necessary to work out the concept theoretically and to understand the essential background. Because of this, most of the work consists of a comprehensive literature research and secondary analysis, which is especially oriented to scientific studies conducted on Mobility as a Service. From the contents of these scientific studies are derived both the essential characteristics and components that make up the peculiarities of MaaS, as well as the transport policy objectives.

Just as well, a literature review will be used to derive the main expectations and impacts that of the MaaS concept, and to determine the main goals that can be linked to MaaS. Furthermore, various case studies are being presented and examined. In a first step, it is intended to conduct a qualitative description of the case studies with the aim to investigate if the most actual pilots and projects integrate the most important characteristics that are derived from the main ideas of the MaaS Concept. In a further step, an empirical survey based on quantitative data is pursued to fulfill the actual aim of providing an evaluation of the actual impacts of MaaS to goals and issues of transport policy. To this end, it is intended to use a set of indicators which allow measuring the effects that can be related to the implementation of a MaaS within a geographical area, in relation to goals set for transport policy. Since MaaS is a completely new approach, this will depend on the condition that quantitative data will be available.If the empirical data is not available for some reason, such as a lack of progress of the pilots or because the data has not been gathered yet, the aim of the survey will have to be changed. In this case, the goals and the set of indicators will have to represent the temporary result of the thesis, and will be designated to be a basis for further researches that can be conducted on this topic.

1.5 Assumptions and Limitations

Due to limited time and personnel, it was not possible to carry out the analysis at a certain depth. The work is therefore not claiming to compile the topic complex in all its facets and details. The aim is to get an impression as to whether, and to what extent, Mobility as a Service can contribute to the achievement of transport policy objectives and thus provide a basis for building up and deepening investigations.

The analysis is based on a qualitative comparison of the expression and "system components" of the existing scientific MaaS initiatives and (pilot) projects. However, only a few scientific reports and studies, which are concentrating on certain topics of the MaaS concept have been completed at the beginning of the thesis. For this reason, the main parts of the literature review are based on these few sources. These main sources set the frame of the work, and are complemented with different contents and statements that could be found on the topic. It is therefore at this point difficult to lead a critical discussion on the statements that have been done on the concept of Mobility as a Service.

Moreover, due to the novelty of the concept, it is expected that the quantitative data available for the implementation of the work is not yet available or freely accessible since current initiatives are currently on test levels. It must be assumed that the significance of the final assessment of the importance of MaaS is somewhat weakened for the strategic objectives of the transport policy. Even if qualitative conclusions suggest that MaaS is effective, the application of quantitative results would significantly increase the meaningfulness and clarify the real significance the concept can develop.

It should also be mentioned that due to the timeframe and the staffing, a more comprehensive quantitative assessment would not be feasible. Such an in-depth analysis would clearly exceed the timeframe and would rather be carried out in a long-term and more in-depth study. A prerequisite for this would be self-evident, as already mentioned, that appropriate quantitative data are available or the possibility exists to obtain it within the framework of a pilot project. Nevertheless, the work is intended to provide a basis for the further study of the MaaS concept as well as its significance, effects, requirements or other questions.

In addition, it is pointed out that the focus of the work is on the importance of mobility as a service on passenger transport. Due to the scope of the work, the consideration of the goods and supply traffic as a component of MaaS was not deepened and only marginally mentioned. It is also assumed that transport of goods requires different conditions and conceptions, as well as other (additional) actors that have to be considered.

1.6 Structure

To achieve the aim of the work, the concept of Mobility as a Service as well as the main reasons for the development of this new vision for the mobility of the future have to be described. Therefore, **Chapter 2** describes the current challenges for urban planning and transport policy as well as social and technological trends that influence the perception of

mobility as well as the future development of the transport sector. Why is the development of MaaS necessary at all, and what essential social trends are to be taken into account?

Chapter 3 deals with the concept of mobility as a service, describing the main idea of the concept and setting a frame for the term of Mobility as a Service. By looking at different definitions, the concept is delimited by its specific characteristics, so that a clear distinction is made between similar mobility concepts. The aim is to clarify the peculiarities of MaaS and to see to what extent other mobility concepts differ from MaaS. Just as well, the core elements are described more detailed as the integrated parts of MaaS.

Chapter 4 examines MaaS's influence on the structure and organization of the transport sector. Since the MaaS concept is an innovative solution, it is assumed that it will have major changes on the transport sector, its structure and the role of the involved actors.

To this end, the proposal for a systemic change in the structure of the transport sector, is explained, followed by the presentation of a new structural approach of the MaaS ecosystem, in which the individual levels as well as the relevant actors and their roles are described.

It is also regarded as essential to explain the business model of MaaS, as mobility is likely to change into a service sector. To this end, MaaS will look at the future delivery of mobility services from the customer's point of view and the economic opportunities that arise from the perspective of transport providers.

In order to be able to assess MaaS's relevance to transport policy, **Chapter 5** contains an assessment of the potential goals which can be followed with the implementation of the MaaS concept in the context of an effective transport policy. These are derived from the advantages and impacts described in the literature as expected by Mobility as a Service.

In **Chapter 6 and 7**, the case study is carried out. A qualitative comparison based on the main, integrated elements of a MaaS is pursued as well as a quantitative analysis of the impacts a MaaS could have on achieving the most important objectives of transport policy for more efficient and sustainable mobility. The results and findings on the intended research are presented and construed.

With the **chapters 8 and 9**, the thesis will be completed with an explanation of how the research on the topic of the impacts of MaaS has to be conducted in the future, and finally be closed with a conclusion.

2. CHALLENGES AND TRENDS IN THE TRANSPORT SECTOR

2.1 Challenges of Mobility

Mobility is an integral part of our society. But the way we move around within our cities is about to undergo far-reaching changes. While transit authorities around the world are constantly looking at ways to improve mobility with low infrastructure investment, moving towards more sustainable approaches does pose some crucial challenges. The main drivers for this are to be seen in some higher-level developments, strongly affecting the development and the changes in the field of transportation. (Beiten 2016, n.pag.)

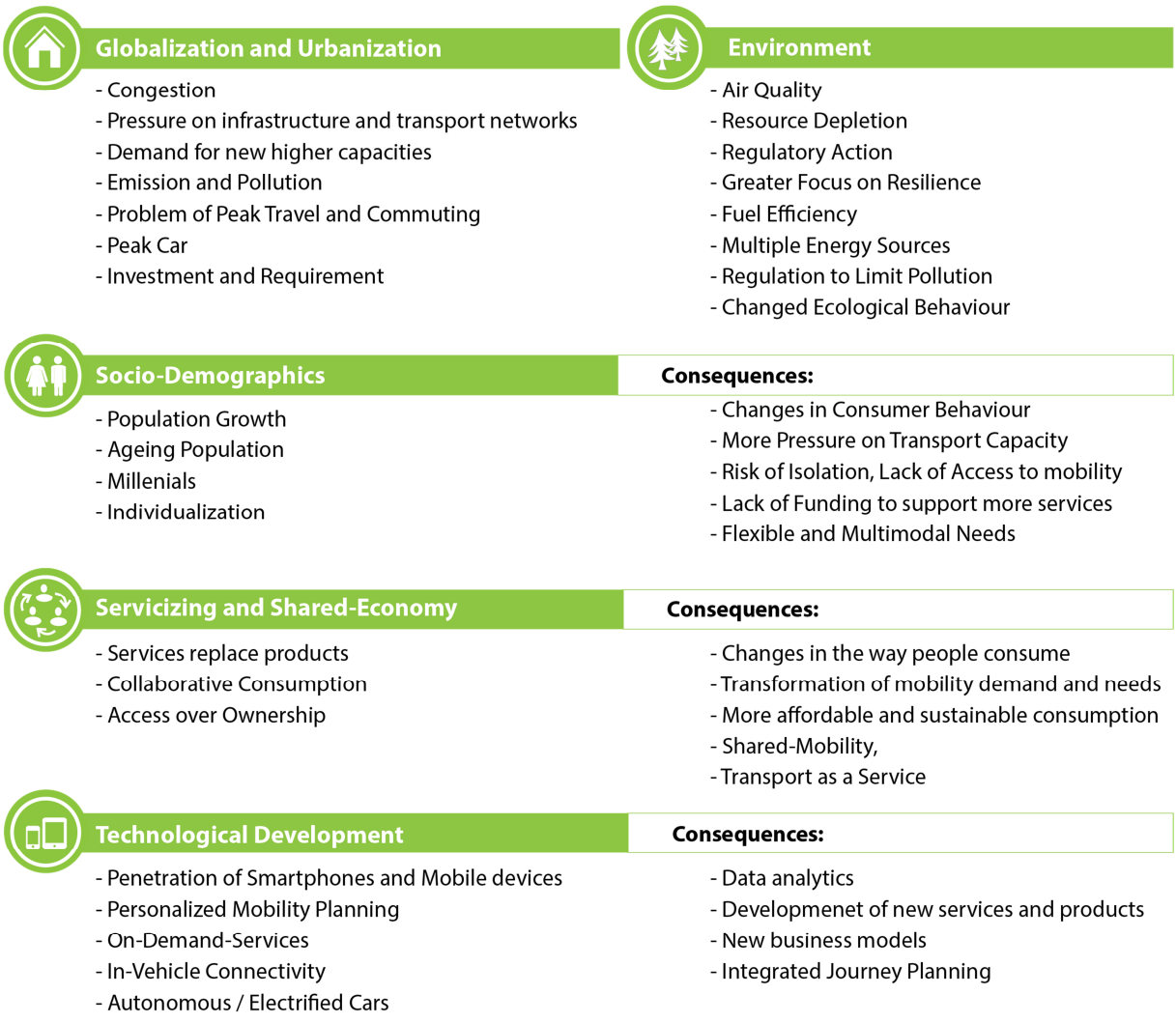

Figure 1: Main Challenges and Trends influencing the future of society and mobility

(Source: Burrows et.al. 2015, S. 5f)

Different trends, recognizable worldwide, are influencing current mobility habits and conventions, thus shaping the society and their mobility needs of the future, having strong effects on many levels of our society.

2.1.1 Globalization and Urbanization

Globalization refers to the increasing geographical scale of economic, political, social, and cultural interactions. It can be partially explained by economic shifts that have resulted from world-wide deregulation, followed by removal of trade barriers and increase in competition. (Heikkilä 2014, p.27)

Globalization entails an increasing demand for mobility. Mobility is more than ever a prerequisite for social and economic progress, and more and more people are dependent on the car. Consequently, traffic is growing. The reasons for this growth are different. Passenger transport is particularly important in areas where living and working are not taking place in one place. Professional mobility continues to expand and become a normal case. Leisure and holidays are also associated with more mobility than before. (Winterhoff et al., 2009, p.16)

Urbanization describes the trend of occupation and concentration of population urban areas. It is expected that the number of megacities with more than ten million people will continue to grow. By 2030, more than 60 percent of the world's population will live in urbanized areas. (Bouton et.al. 2015, n.pag.) Many of them desire to buy a car: automobile sales are expected to increase, especially in cities, with more than half forecasted to be bought in cities (Bouton et.al. 2015, n.pag.) As demand for mobility rises, so do concerns about transportation as one of the leading contributors to global greenhouse gas emissions, congestion, noise and poor air quality in cities. (Buscher et.al. n.d., p.8 & Bouton et.al. 2015, n.pag.)

The growing demand places intense pressures on city resources and infrastructure. Congestion is already close to unbearable in many cities, and the existing transport infrastructure is no longer able to comply with ever-growing number of vehicles. Moreover, inadequate infrastructure causes inefficiencies of transport system, such as congestions and low service level of public transport. is the cause of time loss, wasted fuel, and increased costs. (Buscher et.al. n.d., p.8)

Cities have traditionally sought to solve such challenges by adding new capacity to match demand. However, a capacity-building approach alone is neither efficient nor sustainable. This problem is often attributed to spatial constraints, which inhibit additional growth of transport networks, and increasing budget limitations on physical infrastructure maintenance and renewal. (Buscher et.al. n.d., p.8)

The problem of Commuting and Peak Travel: As the need for trips arises from people's need to be in different places at certain time, there is an increasing demand for a faster and more direct travel in city centers, suburbs as well for intercity mobility. This growing demand often outstrips capacity in large cities, and despite the best efforts of transit agencies, commuting can truly be a nightmare. (Cubic n.d., S.1) In many cities, the high traffic volume during the morning and evening rush hour leads to significant traffic restrictions. (Zukunftstrend 2016-3, n.pag.)

Furthermore, considering the daily cycle of transport demand set out above, a major challenge in the delivery of mobility is addressing the peak demand. This is a question of either

increasing capacity (limited potential in many cities, as explored earlier), or redistributing demand over time and across different transport modes or routes. (Buscher et.al. n.d., p.9)

Mobility demand in cities is highly variable over time, leading to a continual disparity between the level of service supply and demand. The majority commuters needs to travel during short (peak) periods of the day, putting pressure on the transport system, leading to overcrowding, congestion and a negative user experience. In contrast, off-peak surplus capacities imply the under-utilization of physical infrastructure, thus creating a surplus capacity. (Buscher et.al. n.d., p.9)

Hence, one of the key challenges of urban sustainability will be to maximize the utility of existing and planned infrastructure while reducing resource use. While many growing cities respond to increasing peak travel demand by building new physical infrastructure (roads, rails, bike paths, etc.), this cannot be the whole solution. Instead, distributing demand across modes, routes and time would be a more effective approach. (Buscher et.al. n.d., p.9)

However, it has still to be mentioned that there is also a positive aspect, since cities assemble the critical user mass within close proximity for transport assets to be shared and accessed. (Holmberg et.al. 2015, S.10) Generally, it is much easier and more profitable to organize public and other services are in city regions, as the clientele is greater. This applies also to the provision of transport services. Public transport has a more profitable prospect and it can be arranged more affordably in dense areas, due to the economies of scale. (Heikkilä 2014, p.28)

2.1.2 Social Changes

Social change refers to the change of people´s characteristics, such as mindset and behavior, often reflecting personal experience affected by the environment. Heikkilä (2014, S.24) states that "*social generations depict their personalities and their world view of the time period their born in. Thus, representatives of each generation tend to think and act similarly and tend to have the same expectations and ambitions in life*". In the last decades, people's lifestyles have changed significantly. As the world is rapidly developing, the youngest generation might considerably differ from the earlier ones. In this context, generations that will likely shape the future of our society. (Dotter 2016, n.pag. & Heikkilä 2014, p.24)

Ageing Population is a substantial phenomenon in the society in the developed countries, setting new challenges for the approaches of transport policy. (Randelhoff 2017, n.pag.) The ageing population places its own demands on transport systems both in terms of accessibility and availability. Thus, the special needs of the elderly need to be taken into consideration in the design and operation of public services. (Heikkilä 2014, p.30)

With an ageing population will come a larger group who have more incidence of long term health conditions which will mean a greater incidence of having to give up the car. Indeed, free travel concession on public transport for older people, as common in many European Cities, is making many older people think twice about car ownership, or at least giving up that second car. (Dotter 2016.n.pag.) Indeed, aging population could raise the need for individual

services, since a certain spontaneity and independency will be expected and desired from the elderly. Thus a high quality of the transport services will be needed to ensure a sufficient amount of accessibility and independency. Additionally, they require the ease of use, convenience, and extravagance. (Heikkilä 2014, p.30)

Another societal driving force includes the changes in mobility behaviors of the generations Z and the generation Y, the so-called **millennials**, now in their 20s and early 30s. (Heikkilä 2014, p.25) These generations are characterized by declining consumption patterns, having more flexible working patterns and increase demand for personalized and on-demand services. (Holmberg et.al. 2015, S.11) These Social trends are creating what can be seen as either an imminent shift away from traditional modes of transport, or as a huge number of potential opportunities to provide more and better services to customers. (Burrows et.al. 2014, S.11)

While Older Generations pursued freedom through driving cars, Millennials are used to the freedom through the Internet and other information and communication devices. The Generation of Millennials is born to the mobile world, thus, they can be referred to as "digital natives", considering the availability of information and communication as well as mobile technologies as given. (Heikkilä 2014, p.25)

Today, the relationship with the private car is fundamentally changing, thus opening up new opportunities for new mobility approaches. (UITP 2016, S.1) The millennials tend less to value cars and car ownership, and more to value upcoming technology — they care about what kinds of digital and mobile devices they own. (Dotter 2016, n.pag.) More urban than previous generations, young people live and work in cities, and hence are more likely to be less interested in owning a car or getting their driving license. Instead, they take advantage of public transport and new mobility solutions, making personal car ownership particularly in developed countries less attractive. (UITP 2016, S.1)

Indeed, a decline in the number of people making a driver’s license as well as the number of privately owned cars can be noticed especially for the millennial generation; young people prefer to have the choice whether to drive or not. Hence, those generations are more are actively looking for alternatives to the car, shifting the focus from car-ownership to the accessibility of mobility options. (Cubic n.d., p.3 & VDV 2013, S.5) In fact, “cars are no longer a status symbol for young people, and the younger cohort is more adamant in demanding simple, flexible and inexpensive transportation.” (Vale 2016, n.pag.) Millenials increasingly consider cars as appliances rather than aspirations. With attitudes towards ownership changing, it is easy to see how the benefits of a whole-of-transport mobility model is an increasingly attractive option.

Individualization describes the detachment of the consumer from mass movements and traditional life models. (Winterhoff et al., 2009, p. 3) In modern societies, the individual's dependence on traditional ties decreases. Compulsory culture is replaced by multi-selectivity, thus a new variety of ways to make life self-determined. They change mobility behavior and lead to new manifestations of mobility use. (Winterhoff et al., 2009, p.9 & p.14)

Increasing individualization influences the mobility needs and requirements in many ways. Individualization enables a higher flexibility, but requires also a greater spatial mobility. Finally, from the pluralization of the patterns of consumption and living conditions, there is a multiplication of the mobility needs and requirements. As already seen, especially younger generations tend to have much more individual ways to customize their lifestyles. (Winterhoff et al., 2009, p.14)

Furthermore**, signs of hitting 'peak car'**, a plateau or peak in vehicle ownership and motorized and private car travel, can be recognized, especially in more developed countries. Apart from the aesthetic pleasure, owning a car today is mostly a pain. Cars were originally invented as agents of freedom, but to drive (and, worse, to have to park) one in a city is nowadays tantamount to punishment. Considering dense urban environments, urban driving is socially exclusionary and undesirable – leading to congestion, pollution and road accidents. With public transport infrastructure already struggling to cope, cities must look to other alternatives in order to fill the void caused by changing models of car ownership. The solution can't be to stuff more cars into that environment. (Cubic n.d., p.3 & Fritz 2016, n.pag. & Moss 2015, n.pag.)

Today, "Private cars are wasteful and expensive" (Moss 2015, n.pag.), with typical car-owners spending roughly 50 minutes commuting on a daily basis (…) This means that over the time of ownership, cars are unused for over 90% of the time. They require maintenance, insurance and fuel. And that's not even taking into account the hassle of traffic. (Forbes Media 2017 & Moss 2015, n.pag.) The only reason people still own a car the flexibility to get around reliably and cheaply. "But those things are mostly qualities of the usage of the car, not the car itself, which means that they could also be designed into a service offering as well". (Fritz 2014, n.pag.)

Even if the mobility behavior is linked to the car in the future with the need for individual mobility, the **mix of mobility** is changing radically in many places. The car fixation decreases noticeably, and many people become more open to a much more pragmatic means of transport. There is a trend to combine means of transport more satisfactorily and to use them in a situation-specific manner. Especially the younger generations are more open for a wider range of transport possibilities and the practical use of this multimodal offer, independently of one's own lifestyle. They praise the ease of getting around by choosing the most convenient transportation for each trip and the availability of public transport. The reason for this trends often lie on money saving and convenience, and in some communities, it is simply sensible to use public transport. (Heikkilä 2014, S.25 & VDV 2013, p.5)

In addition to the increasing diversity among travel modes, modern lifestyle is featured by increasingly multifaceted mobility. This means that destinations, travel hours, and reasons for moving vary. Moreover, due to new ways of working, such as remote work and virtual meetings, work-related mobility and its reliance of the office hours decrease. (Heikkilä 2014, p.34)

2.1.3 Scarcity of Resources

Environmental targets strongly relate to transport policy, as transport considerably contributes to **climate change**. There are high global and national targets concerning the conservation of the environment, which put pressure on development. (Heikkilä 2014, p.30)

Transportation has an important environmental impact, since it consumes an important part of energy and induces an important part of global emissions, such as greenhouse gases. Even if Vehicle emissions per unit are decreasing, the increasing amount of vehicles evens the reduction out. Additionally, increasing congestion raises emission levels. Moreover, transport causes noise pollution, unties particles from road surfaces, and adversely affects the nature. In Addition, a substantial part of the emissions and use of resources are related to the manufacture and keeping of cars, as the utilization rate of cars is extremely low. (Heikkilä 2014, p.30)

Climate protection and scarcity of raw materials are increasingly becoming a central issue in all areas of politics and society. Strengthened by the development of rising commodity prices as well as the discussion about the rising CO2 emissions, a growing sense of environmental awareness and responsibility develops. (Winterhoff et.al. 2009, p.3) Today, ecology is increasingly perceived as a social responsibility, which means that ecological mobility approaches are being increasingly emphasized. In addition to idealistic reasons, however, this is also practically driven by the need to be able to regulate emissions and traffic in the large cities in the course of a progressive urbanization. (Winterhoff et al., 2009, p.14)

Tackling Climate Change puts a growing attention to public transport, fuel efficiency and alternatives as well as active travel modes (e.g. cycling and walking). Higher number of users per transport asset may mean there's less resource extraction and waste production. (Holmberg et.al. 2015, S.11) Since automobile traffic today is practically entirely dependent on oil, the transition from fossil to renewable energies, driven by politics and society, requires perceptible changes and mobility alternatives. These concern not only the drive technologies, but also the usage structures. Electro-mobility alone will not be able to solve the mobility problems, and will not be able to easily displace the passenger car. (VDV 2013, p.5)

States and municipalities face difficulties in the sufficiency of **financial resources**, since their funds have been continuously declining. The poor availability of funding requires an important increase in the efficiency of operations. Gaining efficiency and productivity might, in turn, require innovation. (Holmberg et.al. 2015, S.12)

Transportation accounts for a substantial portion of public financing and, thus, confronts pressures of intensification of demand. (Heikkilä 2014, S.10f) The scarcity of resources together with environmental issues places the focus on a more efficient exploitation of the existing infrastructure and transportation system rather than extending it, which also the current transport policy promotes. In Addition, people need affordable mobility. Another major challenge is the increasing fuel prices, which are becoming more and more a social problem. People must have the opportunity to have access to mobility regardless of their income and to participate in daily life. (VDV 2013, p.5)

2.1.4 Political Agenda

Not only are urban development is challenging and changing the mobility landscape, but also the political agenda which is now increasingly reflecting concerns about air quality, physical health and wellbeing. Municipalities and governments are actively developing mobility policies to favor active modes, encouraging citizens to walk and cycle more. There is a clear trend to create incentives that make public-transit, biking, and shared-transportation options more available and attractive. (Bouton et.al. 2015, n.pag. & UITP 2016, S.1)

Land Use and Urban Design: Urban planners are increasingly taking into consideration that land use and the population determine the kind of transport is used in the way they design cities. In many emerging economies, cities are still very much in evolution; designers are in a position to make choices to promote compact, transit-oriented, and sustainable cities. (Bouton et.al. 2015, n.pag.)

Walking and Bicycling: More recently, many cities have moved to pedestrianize parts of their city centers. These efforts not only include initiatives restricting access to cars, but also making the streets themselves more attractive to pedestrians. In fact, cities around the world are opening car-free zones to pedestrians and bikers. In addition, many cities are trying to make bicycling safer, easier, and more popular. Bike sharing in particular has hit the mainstream. (Bouton et.al. 2015, n.pag.)

Public Transit: Cities are investing in public-transit improvements. Administrations worldwide are pouring investment into public transit as a way to improve mobility. Many stakeholders like cities and communes have put a lot of effort to digitize their public-transit systems to make public transport more attractive. (Bouton et.al. 2015, n.pag.) Public Transport remains critical for supplying capacity for a large number of people, the positive development is the greater focus on integrating the journey at either end to make the experience as easy as possible for the user without the need to spend time and effort planning and choosing how to make the whole journey. (Burrows et.al. 2014, S.9)

2.2 Trends in the Transport Sector

With the rise in urbanization, transit authorities are facing growing mobility challenges (congestion, capacity, effiency etc.). This poses the question how to deal with increasing number of people and their ever growing need for individual and flexible mobility due to an developing world and increasing globalization. In many cases expanding existing urban infrastructure isn’t an option - either logistically or financially.

As more of the world’s cities become congested and polluted, the transport sector is at the beginning of a significant disruption, as new trends are starting to change behaviors and attitudes. Today, new technologies, social trends and service concepts are emerging, leading to new opportunities to solve the mobility challenge. These trends incorpore the changing society and represent a new way of thinking, giving the opportunity to re-imagine the transport sector. (Bouton et.al. 2015, n.pag.)

2.2.1 Servicizing and Sharing Economy

One solution to better satisfy customer needs is the trend of **Servicing**. This phenomenon, where a service replaces a product, is present around the society, and such transformations have already been experienced in several industries, being in close relation to the **sharing economy** (Collaborative Consumption). (Fritz 2014, n.pag.) By harnessing collaborative modes of production and consumption, the sharing economy has already significantly impacted several other industries and business models, and is currently challenging dominant logics within the field of transport. (Holmberg et.al. 2015, S.11) Well-Known Examples are start-up business like Spotify or Netflix, accessible for millions of subscribers at one time through a monthly subscription, or popular lodging services like AirBnB that are completely changing the hotel industry. (Finger et.al. 2015, S.5)

Servicing and the sharing economy are considered to be more affordable and to preserve natural resources, since fixed costs are distributed to multiple users and managed by a service provider. This proves to be a more cost effective and efficient solution for a great number of people, evidenced by the growth in demand for such services. (Burrows et.al. 2014, S.15 & Holmberg et.al. 2015, S.11f)

Since its uptake, the idea of collaborative consumption penetrating almost every aspect of one's life, changing the way people consume and pushing towards a shift from ownership to access and utilization. (Cubic n.d., S.3) Especially the young, "digital" generations will put a greater emphasis on flexibility and on-demand services and thus be more open to shared services. (Oliver Wyman Group 2017, n.pag.)

That's where the possibility of, e.g. shared-mobility service could radically transform the way people move around a city without building a single road – just as we are already seeing companies like e.g. Airbnb transforming the approach to accommodation without building a single hotel. *"They don't own any buildings at all, they write code, but they've changed the way the fabric of the city is working. Uber doesn't own any cars, but they're changing the nature of mobility.*" (Moss 2015, n.pag.) As far as the transport sector is concerned, these trends appear, especially in urban passenger transportation, in the form of car-sharing, carpooling, ride-sharing and bike-sharing. Today, Travelling by a public transport means is a service. However, the use of public transport services as an entirety is not, yet. (König et.al. 2014, S.11)

2.2.2 Technological Developments

Amongst the major trends that are influencing the transport sector, the introduction of the Information & Communications Technology (ICTs) is among the most prominent ones.

Digitization of society will be one of the most important enablers for a different and more widespread consumption of Mobility. Bringing Mobility to the customers is made possible by the simultaneous availability of multiple technologies such as wireless broad-band, smartphones or tablets, and location-based services as well as connected cars. (Hietanen 2014,

S.1f) Further, this will facilitate the integration of services and people, which forwards sharing and the usage of services (VDV 2013, S.5)

Mobile devices: The increased penetration of smartphones and access to Internet allow users to access information anywhere, connect, and benefit from practical applications helping to facilitate the exchange of information on the go. Smart mobile devices can even be referred to as "mobile offices". (Holmberg et.al. 2015, S.12 & UCL London Institute 2015, S.10f)

Moreover, new applications have continuously been introduced, offering “Intelligent” journey planners, which use live information about congestion, disruption from accidents and the like to suggest the best route, are proliferating. (The Economist Newspaper 2016, n.pag.)

Platforms are the online systems that enable the servicing in the transport. They are essential for users to participate and exploit the excess capacity in transport. Platforms can aggregate individual assets in order to create enough consistency and reliability for the users. With a certain degree of standardization (e.g. billing and user information), platforms can be easily replicated and new applications found. (Holmberg et.al. 2015, S.12)

Big Data Analytics: The value of data and information being generated will be crucial. Transport data, data infrastructure and physical transport infrastructure will together compose the essential platform for mobility services. (Hietanen 2014, S.1f) Analysis can support much-improved decision-making as well as generating new market opportunities by creating completely new products and services not previously available. (Burrows et.al. 2014, S.13)

Universally available Internet has helped facilitate ubiquitous data capture and allow robustly interconnected systems to surface throughout urban transportation networks. The presence of rich and real-time-data will have a tremendous effect on the personal mobility sector. (UCL London Institute 2015, S.10f)

In-vehicle connectivity: Software will play a critical role in optimizing traffic flows. The broad adoption of in-vehicle connectivity, either through the mobile phone or through an embedded system and screen, is opening up possibilities. Drivers get detailed, user-generated real-time data, enabling them to avoid bottlenecks, while cities can use information on traffic conditions to respond to emerging situations. (Bouton et.al. 2015, n.pag.)

Autonomous Driving: The future will be decisively influenced by autonomous vehicles (also referred to as "*autonomous cars*", "*self-driving cars*" or "*driverless cars*", as they represent the latest technological evolutions in the automotive industry. (Heikkilä 2014, p.31) We have already seen rapid advances in the “connected car”—innovations that integrate communications technologies and the Internet of Things to provide valuable services to drivers. Further breakthroughs are advancing the introduction of autonomous vehicles; increasingly, daily news expect that driverless cars will soon become a commercial reality. (Corwin et.al.2016, n.pag.)

Automated cars could potentially greatly contribute to cost savings in transport, as the organization of transportation services, such as bus and taxi services, would be more affordable without staff costs. In case service production costs would become lower, service

fees could also be decreased. Further, autonomous driving could also increase the carrying capacity of roads because vehicles would be able to travel closer together and at higher speeds. This could result in increased use and thus, productivity and contribute to the solution of urban air pollution and congestion problems. (Heikkilä 2014, S.31) By reducing the human factor behind the wheel, autonomous vehicles could cut accidents as well. (Bouton et.al. 2015, n.pag.)

Electric Mobility: Car makers are investing billions of dollars to bring more electric vehicle models to market. With sales leaders Tesla, GM, Nissan and BMW threatening to run away with the EV market, other companies are playing catch-up. Market research predicts that annual sales of battery-powered electric vehicles (EVs) and hybrids will increase and that electrification could penetrate certain market segments. This dynamic could be stronger in cities, where driving distances are shorter and people are less worried about running out of power. (Bouton et.al. 2015, n.pag.)

It's easy to understand why Electric vehicles will be an important part of the mobility of future. In fact, EVs may be able to compete directly with petrol-driven cars on cost a lot sooner than expected. Longer-range, affordable electric cars that operate solely on electricity and are capable of traveling more than 300km on a charge. Plug-in hybrids, capable of operating either on electricity or gasoline, are also getting better. (Hwang 2016, n.pag.)

In Addition, the Lack of charging stations—so-called "range anxiety"—will be a lower barrier to wider EV use than today, since Utilities and companies are doing efforts to increase the number of charging stations at workplaces, apartment complexes, campuses, transit stations and other public gathering places. (Hwang 2016, n.pag.)

2.2.3 New Mobility Services

New Start-Ups are thinking mobility in a new way: The uptake of the sharing economy and technological innovations are opening up new space for market entry. Today, the transport sector is being opened up by a myriad of start-up companies exploiting new potentials and disrupting long-established companies and practices. By the creation of innovative new products and services, making transportation will become more multimodal, on-demand and shared, increasing consumer choice and convenience (Burrows et.al. 2014, S.15 & Bouton et.al. 2015, n.pag.)

Car-sharing-, Ride-hailing- or On-Demand-Shuttles services are already at work in hundreds of cities around the world, enabled by smartphones and backed by substantial venture capital. Especially Ride-(or E-)Hailing is dramatically revolutionizing the on-demand industry, with the limousine brokering service Uber as the most well-known example, covering the taxi-segment and now starting to offer services very close to public transport. (Hannon et.al. 2016, n.pag.)

Which of these mobility services and underlying business models will survive and scale up remains to be seen. The Key for viability and scale up of mobility services is the sustainability

of economics – providers have to ensure that operating expenses and services are competitive. Since the Consumer will be choosing from a range of options; convenience and cost will therefore be critical factors.)It is expected that the market will weed out services that fail on those counts. (Bouton et.al. 2015, n.pag.)

The impacts on existing industries: The basic understanding of roles will change as a result of the shift from ownership to usership, and the ever-increasing range of mobility and transport technologies. The various permutations of car-sharing, car-pooling and ride-hailing pose a big threat to vehicle manufacturers' sales. Established players need to be aware that their current competitors may not be their most dangerous competitors of tomorrow. Market participants know this as the risk of substitution and start to re-think their business strategies. (Fritz 2014, n.pag.)

The most traditional carmakers are already busily reinventing themselves as mobility providers, by investing in e-hailing and On-Demand services. Some others have launched mobility services, especially car-sharing, of their own, like Daimlers Car2Go, Ford´s GoDrive or DriveNow by BMW and Sixt. (The Economist 2016, n.pag.)

2.2.4 New Approaches towards Mobility

The transport sector is at the start of a major change, being disrupted by the sharing economy, new innovative technologies and upcoming new mobility opportunities. This leads to the need of a new way of thinking in society as well as in the planning and organization of mobility perception and provision (both by users and providers) in transport sector.

Due to the problems and challenges set for urban mobility (congestion, time loss,…), the economical and environmental issues as well as the social changes, most developed countries are reaching peak car, provoking changes in consumer behaviour. The collaborative economy and technological developments jointly enable customers to be more selective. There is an increasing trend that people are disengaging themselves from their routines of choosing travel modes twards a more flexible and multimodal behaviour. (Burrows et.al. 2014, S.28 & Heikkilä 2014, p.32)

Likewise, governmental and political visions are shifting towards new priorities in transport planning. The old-established design approach could be seen as mobility-based, in which the lack of infrastructure capacity was countered by expanding road network, has strongly contributed to car travel. The purpose will no longer be to improve the transport system by doing more or building more capacity, but by doing things in a smarter way. (Hietanen 2014, S.1f) The modern paradigm is shifting to a more access-based view, concentrating on creating access as the fundamental way of aim of travel. (Heikkilä 2014, S.32)

Thus, the Transport Sector is re-defining itself, providing the means to a more flexible mobility. The focus is shifting, from solely providing (urban) transport networks (i.e. buses,

trams, trains or infrastructures) to what mobility actually means, focusing on what people require and where the supply is needed. (Burrows et.al. 2015, S.27 & S.28)

More modes will be considered as an integral part of an integrated transport networks. As alternative mobility services start to expand, traditional transport modes (such as bus, train or tram) become more blurred. This will be reinforced by customer demand for flexibility that will see more emphasis on switching between modes as well as using the collaborative economy to greater effect. (Burrows et.al. 2015, S.27)

Public Transport Operators have to perceive alternative mobility services (such as car-renting or Ride-Sharing companies) rather as complimentary transport solutions than as unwelcome competition. Rather than competing, it will be crucial to increasingly look into ways for private players to be an equal partner in shaping this future. (Cubic n.d., p.5 & Goodall et.al. 2017, n.pag.)

In Addition, due to the rapid evolution and ever more significant applications of the ICTs, boundaries between the different transport modes are about to disappear: a new data layer will create an intermediate level between the different means of transport and their users. For the user, the focus is therefore no longer on the mode of transportation, but on mobility. As a consequence, mobility will increasingly be seen as an information service with physical transportation products, rather than a transportation product with additional services. (Finger et.al. 2015, p.2)

Just as the service-orientation, transport will be more centered around the customer rather than as a provision to the customer. This is a profound shift in focusing on the User experience, brought about by the increased information, as well as a more open-minded attitude of the customers towards new mobility services. (Burrows et.al. 2015, S.27) The widespread impact of social networks is leading the user to take a more dynamic, pro-active role as a developer and data producer in the transport system. Instead of being pure recipients of a service, customers will contribute to the information available and to the quality and reliability of the service on offer and hence develop a sense of co-ownership of the service (European Commission2014, p.3)

Finally, a clear shift towards an integrated, whole journey approach can be recognized. Customers start to perceive transport as a whole network and to understand the full range of opportunities available in a more seamless manner. There will be a clear and growing demand for easy journey planning options as well as the means of purchasing these options. These journeys must be available more flexibly and the ability to make them on-demand is opening up the market to alternative services and products that meet the expectations of users. (Burrows et.al. 2014, S.11 & p.28)

Traditionally, the focus of the transport sector has been about the provision of a clear, established range of transport modes, with fixed places and timetables. It has been for the customer to purchase and use these services by their own calculations and try to make them fit with their own individual requirements and preferences. However, that offer is very

fragmented and impersonal – there is little effort to tailor the service and to integrate it in a way tailored for every customer. Passengers always had to plot their whole door-to-door journey, with the 'last mile' element always seemingly being outside of the system and therefore requiring riders to plan, book and pay separately for each leg of the journey, making the systems troublesome and frustrating to use. (Burrows et.al. 2014, S.3 & Cubic n.d., S.5)

Hence, there is a value in bringing seamless integration to customers across their entire journey. With an integrated mobility approach available, mobility will be truly more of a service than a single transportation solution. (Burrows et.al. 2015, p.11) This new thinking, often referred to as "Intelligent Mobility", is rapidly developing, as governments, transport authorities, businesses and customers start to explore the huge potential for unlocking major opportunities and improving a wide range of outcomes by exploring the feasibility of new integrated transport models. (Burrows et.al. 2014, S.1 & ITS International 2017, n.pag.)

The current organization of the transport industry, with separate organizations for the various modes, does not reflect how individuals think about and plan their journeys. The lack of flexibility, dealing with network disruptions and the complexity of using a variety of transport modes (i.e. different payment methods, subscriptions, lack of integrated information etc.) discourages many people from using them. (Burrows et. al. 2015, S.17 & UCL London Institute 2015, n.pag.)

Mobility as a Service (MaaS) can be identified as one of the most promising concepts, coming about from a very real need for more intelligent transport solutions. By providing an integrated service for customers, the task of getting customers to their destination can be more flexibly delivered. (Burrows et.al. 2015, S.19)

3. THE CONCEPT OF MOBILITY AS A SERVICE (MAAS)

3.1 Idea of MaaS

The Concept of Mobility as a Service is based on a specific mobility service that seamlessly combines various transport options together into a single intuitive mobile app. It combines options from different transport providers into a single mobile service, integrating the payment of services and trips, thus removing the hassle of planning and one-off payments. (MaaS Global n.d., n.pag.)

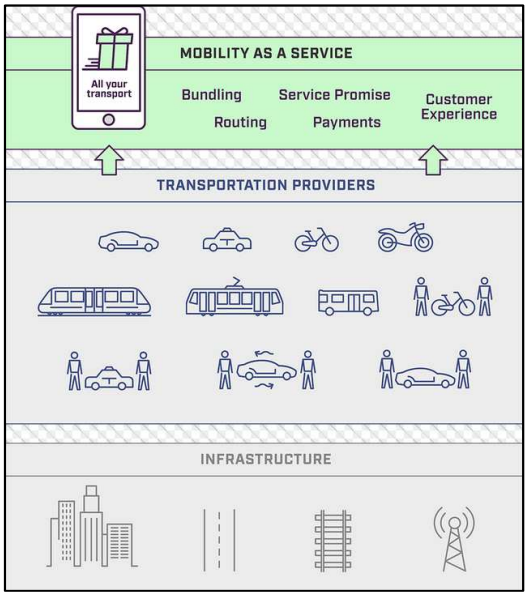

Figure 2: The MaaS Concept

(Source: MaaS Global n.d., n.pag.)

MaaS Alliance (2016, n.pag.) says that *"…the **key concept** behind MaaS is to 'put the users, both travelers and goods, at the core of transport services, offering them tailor made mobility solutions based on their individual needs. This means that, for the first time, easy access to the most appropriate transport mode or service will be included in a bundle of flexible travel service options for end users'.*

The Idea is relatively simple, yet revolutionary: bundling different transport means, public and private, into one easy-to-use package for customer. The service is provided to customer over one single interface of a mobile application in which booking and payment are included. (Hietanen 2014, S.1) Once a route has been chosen, the service makes all the bookings needed, as well as ensuring that hire vehicles are available and public-transport sections are running on time. Costs will be displayed for every option, making clear the trade-offs between speed, comfort and price. (The Economist Newspaper 2016, n.pag.)

The distributer would design customized mobility packages allowing different volumes of usage of various transport and mobility services. (Finger et.al. 2015, p.3) The packages would

cover a range of fees from the different transport modes, and users wouldn't need to manage multiple passes, fees, or payment modes. (Vale 2016, o.S) They will be charged per trip or a monthly fee for a limited distance. The monthly fees may vary depending on how much transportation is needed or for instance, based on time or comfort level. (Fountain 2016, n.pag.)

For extra convenience, MaaS can include other value added services like deliveries for groceries or restaurant meals. It allows people to go places and live their lives with more ease than ever before. (MaaS Global n.d., n.pag.)

MaaS Global (n.d., n.pag.) describes the MaaS concept "as a carefree, environmentally sound alternative to owning a car. It means a complete set of mobility in all life situations by giving users a service level promise. From office commutes to weekend getaways, daily travel will be managed in the smartest way possible, working out the best option for every journey".

3.2 Conceptual definition of MaaS

Since Mobility as a Service is a relatively new concept, only a handful of pre-/case studies exist. This is why it is difficult to give clear interpretation of the term Mobility as a service, since a commonly agreed definition doesn´t exist yet. However, the lack of a clear definition of MaaS may also be considered good since the transportation sector is in a deep transition where a definition one week may become obsolete the next. The current innovativeness level in the MaaS domain is high and actors and roles grow and change almost on a daily basis. (Holmberg et.al. 2015, p.7 & p.21)

Nevertheless, it seems to be important to take a look at various approaches to explain and to define the scope of the term Mobility as a Service and to develop a clearer understanding of its main ideas. This might be useful to spot and to highlight the most important MaaS elements.

Following the statement of Holmberg et.al. (2015, p.8.), it is indeed not easy to completely discern which services concretely fall into the concept of MaaS. Some approaches include already "simple" mobility services like Uber, others start with extended travel planners while yet others claim that MaaS is equal to a combined mobility service (CMS), i.e. that MaaS provides a mobility service based on a platform of multiple and different modal services like public transport, taxi, car sharing, bike sharing etc.

As Mobility as a Service is seen as one of the most promising initiatives, it is often misinterpreted and equated with every service that fits the concept of mobility. This is how MaaS is understood as a common, collective term for innovative mobility services (such as mobility services), such as car and bike sharing or on-demand services. However, MaaS has more to be understood as a further evolutionary stage of Intelligent Transport Systems (IVS), which as integrated mobility offers a certain transparency in tariffs and ticketing in the sense of a service-oriented payment and the associated billing. (Flügge et al., 2016, p.211 & p.228)

MaaS-Approach of Swedish Viktoria Institute

In their report, Holmberg et.al. (2015, S.21ff), introduce a model in which they describe different types of mobility services that are emerging. The most important distinction of what their report describes as Mobility as a Service are the approaches to the Concept as an Int*egrated Public Transport System* and as an *Combined Mobility Service*. Both of these versions are often referred as MaaS-services.

Integrated Public Transport Systems aim at designing public transport in a way that it can easily integrate other mobility offers (e.g. car sharing, bike sharing, taxis, etc.). (…) Similar to the extended multimodal planner, the idea is that customers should be able to plan, book, and pay for the whole journey with several transport modes in one service and thus to purchase the best mobility offer for their specific trip based on real time transport data. ((Holmberg et.al. 2015, S.7 & S.23)

Combined Mobility Service are meant neutral third-party, so-called Mobility Operators, that offer a wide range of combined mobility options and offer it to users based on subscription and unified invoicing, possibly also with some form of repackaging of the included services. CMS is also supported by some form of digital interface for the customer. (Holmberg et.al. 2015, p.22f)

The main difference is that through Integrated public transport represents mainly a technical integration which simplifies the shift between modes for a single trip. In contrast, through the provision of a subscription and a re-packaging of included services, CMS is both of a business model and technical platform, which draws its profitability on the reduction of privately owned cars. Hence, Combined Mobility Services (CMS) could be referred to as an important subset of Mobility as a Service. (Holmberg et.al. 2015, p.22f)

Approach of the Finnish Transport Agency

Despite the vast interest to MaaS, the Finnish Transport Agency states that there is no commonly accepted definition for it, which has led to different interpretations of the term and the scope. Technically oriented descriptions of MaaS relate to intelligent traffic, new transport technology and business models changing the roles of public versus private organizations and financing. Further descriptions include the expanding range of traffic and mobility services, service packages, digital informational services, multimodal and seamless transport chains, environmental issues, as well as changes in consumer behavior and sharing economy.

The line between the different viewpoints is vague, as none of them seems to be incorrect. From the user's viewpoint Mobility as a Service, MaaS, is a bundled market offering for consumers, providing one or several mobility-related services for easy and reliable travelling (Finnish Transport Agency 2015, S.9)

Approach of the MaaSiFie project consortium

Following the idea of the MaaSiFie project consortium (König et.al. 2016), another useful approach is to list and review a number of definitions of the MaaS Concept given by different sources. A part of these have also been found in the literature review for this work.

Sampo Hietanen (2014, S.1) sees MaaS as "a *mobility distribution model in which customer´s major transportation needs are met over one interface and are offered by a service provider. Typically the services are bundled into packages – similar to mobile phone price-plan packages. The central element of MaaS* ***requires a mobility platform*** *that offers mobility services across modes". (*

Atkins Mobility explains that MaaS offers "*the provision of transport as a flexible, personalised on-demand service that i****ntegrates all types of mobility*** *opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easy as possible" (Burrows et.al. 2015, S.19)*

Sonja Heikkilä (2014, S.8) defines MaaS as "*a system, in which, a comprehensive range of mobility services are provided to customers by mobility operators. These mobility operators are companies that buy mobility services (i.e. transport like public transport, taxi, car sharing, bicycle etc.) from service providers, and bundles them in packages for an easy customer services".*

The UCL London Institute (2015, S.11f) for their part say that MaaS "*stands for buying mobility services based on consumers´ needs instead of buying the means of transport. Via MaaS consumers can buy mobility services by using just one single platform and a single booking and payment. The platform provides an intermodal journey planner (…combinations of different transport modes, such as car-sharing, car rental, underground, rail, bus, bike-sharing, taxi), a booking and single payment method (single payment for all transport modes) and real time information".* Therefore, the UCL London Institute says that *"MaaS offers door-to-door seamless mobility service, which users can use either as pay-as-you-go or they can purchase mobility packages based on their family´s needs*".

Schweiger (2016, S.1f) states that the most important characteristic differing MaaS from other Mobility Service is that MaaS concept includes the provision of "packages" bundling transportation services for the customer, typically on a monthly basis. Further, MaaS is expected to be operated by one entity, which can be a public or private organization. While a simple mobility management can be performed by one organization, these is, in contrast to MaaS operators, not necessarily responsible for negotiating financial relationships with transportation service providers.

Finally, with their definitions and viewpoints towards Mobility as a service, the **MaaSifie Project Consortium** tries to determine an own definition for the approach to the MaaS concept. Hence, they consider Mobility as a Service as an "*integrated mobility solution, offering multimodal and sustainable mobility services addressing customers transport needs by integrating planning and payment on a one-stop-shop principle, (…)".* (König et.al. 2016)

3.3 Core elements: Integrated Parts of MaaS

The review of the definitions allows a scanning for “important and crucial factors for MaaS” identify factors that have a high probability for being relevant more broadly for the Maas phenomena. As a result, following the aforementioned approaches to the concept of Mobility as a Service, the following components can be identified as important and integrated parts for the deployment of MaaS concepts, creating a recognizable identity for Mobility as a Service and defining a concrete frame for the concept.

- Service provision by a Mobility Operator
- Combined Mobility: Integration of all means of transport (Public Transport, Shared Mobility, Autonomous and Electrified Mobility)
- Mobility Platforms, including Multimodal traveler information
- One-Stop-Shop
    - Integration of planning, ticketing and payment
    - Mobility Packages
    - Special offers, discounts and frequent customer programs

A strong focus is especially placed on the integration of different transport modes with the aim to bring people to use more alternative transport modes instead of only using their own private cars. Further, available ICT Technology is seen as major preconditions as well, providing new mobility service concepts to the respective end-users. This opens up opportunities for the provision of multimodal traveler information and an integrated One-Stop-Shop. (König et.al. 2016, p.10)

3.3.1 Combined Mobility

Public Transport: A highly effective MaaS is based on flexibility and a high level of convenience. Combined Mobility, meaning offering integrated mobility services, is considered the only viable approach to form a complete and coherent mobility solution that is able to compete with the private car in terms of flexibility, convenience and cost-structure. (UITP 2014, n.pag.)

Even if Combined Mobility is considered to be the key to an integrated mobility offer, the VDV (2013, S.4) emphasizes that an efficient public transport remains the key element of every mobility strategy, since it is a sustainable public service, having the broadest customer base. Public transport is the most efficient solution in terms of capacity and will continue to outperform all other modes in the efficiency of the use of space for moving a maximum number of people. (UITP 2016, S.3)

Yet, since public transport is excessively structured, it is not able to meet individual needs in terms of flexibility. In order to provide suitable and individual mobility services, public transport needs to be complemented by various additional mobility services. Merely these services together are able to fulfill customer needs and compete with the possession and usage

of private cars. (VDV 2013, S.4) There will always occur situations where car usage is not only necessary but also justified. In these situations, car-based services are the obvious solutions that complement public transport as they offer the benefits linked to the flexibility of the car. (UITP 2016, S.2)

Yet, alternative mobility solutions cannot provide a substitute form of transport for the bulk of mobility requirements. It is obvious that they are not going to cover the main part of the citizen's trips, but they provide the key to less car ownership and in aggregate less car use. (UITP 2016, S.3f) Whilst walking, cycling or shared modes are excellent in complementing public transport in providing a door-to-door transport options, they do not have the capability or capacity to meet citizens' mobility needs or solve traffic congestion on their own. (UITP 2016, S.4)

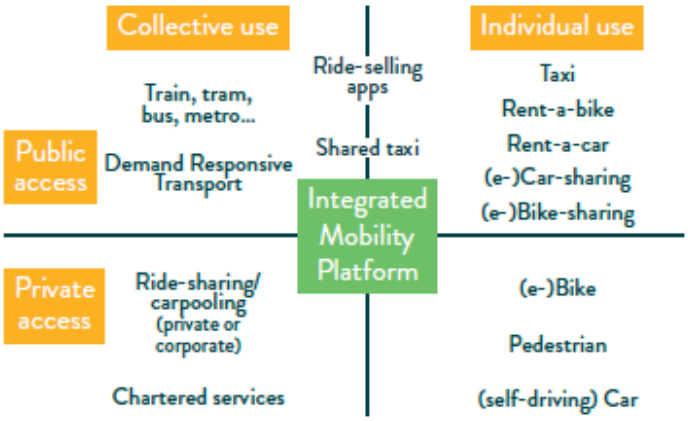

Figure 3: Combined Mobility Offers

(Source: UITP 2016, S.2)

Shared Mobility: A broader mix of mobility services is the key to ever more complex and intense mobility needs. Therefore, new demand-responsive and shared mobility solutions form an integral part of MaaS, aiming to provide an integrated combination of different sustainable mobility services that most effectively challenges the flexibility and convenience of the private car. There are range of alternative mobility solutions, such as ride-hailing apps (e.g. Uber), car-sharing (e.g. Car2Go), ride-sharing apps (blablacar), taxis, bicycle and bike-sharing, car-pooling or demand-responsive transport. (UITP 2016, p.4 & p.7)

The Sharing Economy appears in the transportations sector especially in urban passenger transportation, in the form of car-sharing, car-pooling, ride-sharing or bike-Sharing services. All sharing opportunities applied to the transport sector are summarized as "shared mobility". Access to shared mobility is facilitated by ICT Technologies, especially by the provision of smartphone or web-based applications. Some sharing concepts integrate already booking, reservation and payment of vehicle rides. (König et.al. 2014, S.11)

In addition, a range of **on-demand transportation services** emerge, often combining shared-mobility and Ride-hailing services. They can be seen as "*an advanced, user-oriented form of*

public transport characterised by flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passenger's needs"(Schönig 2016, n.pag.)

Autonomous and Electrified Mobility: In Addition, MaaS offerings in the future will likely incorporate autonomous vehicles. Although autonomous-vehicle technology is still in the pilot stage, it is looking promising. However, driverless technology is not yet ready to run on a mass scale, and there are a number of complicated issues to work out, such as regulations around safety, liability, data use, and privacy. Still, Deloitte estimates that by 2040, up to 80 percent of passenger miles travelled in urban areas could be in shared autonomous vehicles. (Goodall et.al. 2017, n.pag.)

There are many pilots for driverless connections planned and expected to be launched. Most major car manufacturers are starting to develop driverless cars; for example, Ford and BMW have announced their intention to mass-produce fully autonomous vehicles for ridesharing. Similarly, Uber is testing its driverless cars in Pittsburgh and Singapore has begun testing a very limited driverless taxi. (Goodall et.al. 2017, n.pag.)

What is more, is that electric mobility will be an integral part of combined mobility solutions. Even with low oil prices, it is stated that the future for electric vehicles is bright. Plummeting battery prices, longer-range models, and more charging stations are driving forward electric vehicle sales. (Hwang 2016, n.pag.) Electric and fuel-cell powertrains tend to offer greater propulsion for lower energy investment at lower emission levels. (Corwin et.al.2016, n.pag.)

Electronic Vehicles (EVs) have gained importance as the world looks for ways to reduce the carbon pollution and oil dependency that fuel dangerous climate change. Studies found out that widespread electric vehicle use could contribute to a cut of carbon pollution in an amount that is equivalent to the emissions from 100 million passenger cars. Further, it also would reduce other harmful pollution, such as ozone and particulate matter. (Hwang 2016, n.pag.)

In order to become really attractive, the different sustainable modes need to be coordinated, planned and delivered in an integrated way. From a physical perspective (coordinated network planning, stations, urban planning) but also from an information perspective, trough a one-stop-mobility shop acting as personal mobility assistant offering travel information, booking and ticketing. (UITP 2016, S.7)

3.3.2 Mobility platforms

Integrating the transport system as a whole in order to connect up the various modes of mobility and all related information is one thing. The other thing is to provide a simple, integrated platform that offers mobility services across modes. (Burrows et.al. 2015, S.21) Therefore, Mobility platforms constitute an integral element for the implementation of integrated mobility solutions such as MaaS.

A mobility platform could be considered a virtual market place for transport services. Currently these are for the most part distributed directly via their producers. Once it becomes lucrative, producers will take their product to the market instead of distributing it themselves. Comparisons can be made to booking platforms in other sectors (e.g. airline tickets). (Finger et.al. 2015, p.7f)

Mobility platforms shall enable the integration of the transport modes and thus the possibility for customers to purchase "mobility packages" granting a defined volume of access to public transport, shared mobility or other demand-responsive mobility solutions. (Finger et.al. 2015, p.1) Hence, the role of data and information will be crucial; transport data, data infrastructure and physical transport infrastructure will together compose the essential input for a multimodal platform for mobility services. (Schönig 2016, n.pag.)

Open Interfaces

The customer expects a single, open interface which is connected with the whole network in order to easily understand their options for any particular journey. (Burrows et.al. 2015, S.21) Open interfaces are required to include access to transport modes, timetables, real-time location information and payment systems. The following are listed the most important components of an interface, to offer a seamless and integrated transport service. (Hietanen et.al. n.d., n.pag.)

- Multimodal Traveler Information
- Multimodal Journey Planner
- One-Stop-Shop
    - Booking System
    - Integrated Ticketing
    - Payment Solutions for all transport modes along a trip chain

The design of the services and interface makes the difference. Similar to app design the user interface needs to be compelling. Barriers and thresholds need to be low. Examples of thresholds are to stop the service or modify the subscription. Mobility-as-a-Service is about gaining control over the cost and efforts. (Flügge 2016, S.213)

Integrated Journey Planner

The customer is provided with a dynamic journey management service that keeps the user informed in real-time. Based on literature review, the following components should be included in an integrated journey planner (Burrows et.al. 2014, S.14 & Datson et.al. 2016, S.12 & Holmberg et.al. 2015, S.130 & UCL London Institute 2015, S.52f):

- A **personalized Journey planning** service, which allows a customer to plan their journey based on their personal preferences – e.g. time, cost, comfort, convenience.
- All **transport modes** available are considered in planning a route. If there are multiple operators available for one mobility service (e.g. car-sharing, taxi, …), the journey

planner is able to recommend the “best” option based on the preferences of the user (budget, modes,…)

- **Location and navigation services** can help people undertake their journeys more easily.
- An **interactive map**, offering a full coverage of locational information for all transport modes and stations. User can be informed about on-foot distances, durations and directions to a particular station
- **Price and Fare Information** (e.g. prices of individual modes and total journey price) is are available to support the user´s decision. Journey sections that require advanced booking can be identified.
- **Live and available travel information** with nearly all transport providers having their own services to provide customers with better information at the point of use. Suggestions about viable alternative modes or routes will be provided to tackle risks of any delays, cancellations and other unexpected disruptions in order to maintain transport efficiency.

Multimodal traveler information

With the evolvement of ICT technologies (web-and app-based) leading to growth in highly personalized information and transportation services, multimodal traveler information service is an important factor for smart and seamless door-to-door mobility integration. (König et.al. 2016, p.12f) Multimodal information allows proper interchange facilities to be effectively identified and properly planned. By incorporating real-time traffic information, it allows passengers to take predicted delays into account, and thus improves the reliability of their journey. (European Commission 2014, p.2)

Providing travelers with accurate real-time information before and during the journey is not just aiming at providing benefits like reduced transport costs to individuals, there is also possibility to enable more efficient transport network operation. Multimodal Information is therefore a key for the integration of different transport modes on a digital level as well as on an organizational level. Under these circumstances multimodal traveler information provides the basis for the deployment of MaaS service concepts. (König et.al. 2016, p.12f)

There already exist different locally and / or nationally available traveler information services, yet they still remain very fragmented in what they offer, in regards multimodal transport information, sharing or ticketing features, there are very similar ICT technologies being used for different applications. (König et.al. 2016, p.12f) Some services incorporate for instance: real-time information on PT (public transport) schedules, routing information for different transport modes, including journey times, fares and / or even in some cases information of sharing facilities. In this respect, the European Commission is fostering the connection and integration of different multimodal traveler information service on a cross-border level as well, in order to provide a harmonized and seamless routing information on the European network. (European Commission 2014, p.1ff)

3.3.3 One-Stop-Shop

The following service features are included under the termination “One-Stop-Shop”: Integrated Ticketing, Reservation / booking, payment and enforcement / combined billing.

Integrated Ticketing

Flügge et.al. (2016, S.139) use the term of ***Account Based Ticketing*** or ***Smart Ticketing*** within the discipline of Intelligent Transport Systems (ITS), referring to a user-dependent and subscription-based billing. ***Smart Ticketing*** as important factor for seamless transport system. In most cases different modes of transport provide different pricing schemes for tickets, therefore a combined and integrated ticketing might already ease the access of different modes of transport. (König et.al. 2016, S.12)

There already exist new forms of electronic ticketing on mobile devices (smart cards, mobile phones etc.), integrating and combining all transport methods on a single ticket is the natural partner of full availability of multimodal travel information and planning services. (European Commission 2014, p.3) A smartcard can serve as the sole ticket to access mobility services. As the technology becomes more mature, smartphones can be used as the sole ticket instead of a card. In this case, the smartphone would be scanned in the same way as a smart card would be to access the modes. (UCL London Institute 2015, S.54)

However, it could be augmented that Integrated Ticketing though is not necessarily about having one ticket for the own journey but having one ‘wallet’ for several tickets. By creating a link between Travel Information, Journey Planning, Payment and Smart Ticketing the customer experience consistently meets their highest expectations, which can foster co-modality and intermodality. (König et.al. (2016, p.12)

On the other side, a complete ***ticketless travel*** would be an even more valuable incentive to encourage travelers to combine several forms of transport. This boosts the ability to travel by multiple modes of transport, while only needing to purchase one ticket for the whole journey and getting access to all transportation modes required for any given journey by only using a sole smartcard or smartphone. (European Commission 2014, p.4 & Goodall et.al. 2016, n.pag.)

Ticketing as a MaaS Component especially requires integration with other MaaS Service components in order to be effective. Ticketing is just one step in the “Seamless Customer Travel Experience” within MaaS concepts. From the initial Journey Planning through Fare Selection it must be possible to customers to seamless access Ticketing through the users preferred distribution channel, using the identity, purse or tickets in their preferred wallet wherever accounts and payment methods are established (e.g. via credit cards, debits etc.). In this respect annual / seasonal / monthly cards, one-way ticket solutions and reservation will be under the same umbrella term of ticketing. (König et.al. 2016, p.12)

Therefore, Ticketing could contribute to the overall improvement of the transport network level of services, image, accessibility, with the main aim to facilitate and/or increase the use

of alternative transport and so contribute to the overall political goal of developing a sustainable transport policy. (König et.al. 2016, S.12)

Booking / Reservation

The booking system follows the journey planning stage, giving the user the ability to choose a mode and to execute a required booking or reservation (e.g. seats on public transport, car-sharing, taxi). Prices and fares are presented to the user, so that they can make informed decisions when booking over certain companies. In a best case scenario, they receive a "booking complete"- message with the information of the seats / car / taxi so that the travelers are informed prior their journey. In addition, if vehicles are equipped with GPS devices, it can also be possible to locate the booked service.

However, it must be clarified that sufficient travel flexibility is still guaranteed since not all parts of a journey have to be booked ahead and any required bookings are only for securing usership. (UCL London Institute 2015, S.53)

Payment and Enforcement

The complexity involved in delivering a service that spans multiple modes of transportation, with multiple providers, for a single, discounted fare has stymied many an offering. Many fare structures are old and complex, with ticketing schemes involving zones, day tickets, a variety of discounts/concessions, and fare ceilings. This problem should be addressed so that the public understands what it is paying for. The contactless fares in London, for example, are capped by daily and weekly rates, so that users never pay more than the cheapest equivalent ticket. (Goodall et.al. 2017, n.pag.)

MaaS offerings will likely need an integrated end-to-end version of pay-as-you-go, where users pay for the entire trip and there is pricing integration across modes. A system may also need to be put in place to manage physical gates, with personnel checking identification and managing fraud. (Goodall et.al. 2017, n.pag.) To go further, it should be possible to make Contactless payments using credit/debit cards, smart cards, key fobs or other devices like mobile phones. This system has been around for a while, and now it's being used more and more for transport too. (Schönig 2016, n.pag.)

MaaS offerings include two types of payment options:

- The **pay-as-you-go option** works like most route-planner apps. A trip can be organized as a single trip chain, but the user would then pay, as they travel, separately for each leg. The difference is that they pay the whole trip in one go, independent of transport means. So if you need to take the train, bus and then a taxi in one trip, it's all one payment, made automatically via your smartphone. (Schönig 2016, n.pag.)

- The **monthly subscription** enables the operator, either a public entity or a third party, to "purchase" the services in bulk for users, and then pass along a discount. Users acquire and pay a monthly mobility plan suited to their specific transport requirements. They include all public transport options to cover everyone's individual needs. (Schönig 2016, n.pag.)

Since especially Mobility packages constitute an important core element of Mobility as a Service, the design of mobility packages is described further.

3.3.4 Mobility Packages

The provision of different packages for different user groups can be seen as a new market approach. The customer makes a contract (a service level-agreement) with one commercial operator, who provides them with all the services chosen and configured by the users, depending on which suits best their current need(s). The terms of contract may vary, and are up to the customer and the operator to negotiate. However, mobility packages (may) include at least the following services (Hietanen et.al. n.d., n.pag.):

- Inclusion and Use of all of all transportation modes
- Including transport related service (city logistics), home deliveries, etc.
- Roaming in other cities and countries
- All fully accessible with one mobile tool, and everything in one monthly bill

As already seen, the easiest way to think about Mobility packages is to compare it to a mobile phone subscription. Some users need loads of data, others do not but need lots of calls. Others don't want a contract but pay as they go. That's why mobile service providers offer a variety of plans and casual options. (Schönig 2016, n.pag.) MaaS works in a similar way, offering different mobility packages to consumers, who select the most appropriate one, opening up a range of modes for easy use through one integrated service. (Bradburn 2016, n.pag.)

The concept is simple: pre-purchase mobility packages to get better value for your money. The whole service is built on providing the user with as much flexibility as possible. The price of each mobility package should be less than each element would be separately in the pay-as-you-go system; much like it works in other service industries. (UCL London Institute 2015, S.50)

The mobility packages have a fixed monthly price and include various combinations and "amounts" of transport modes. These amounts can be defined either in duration, distance or monetary terms. The denomination depends on the agreements between the service providers. The Users have the possibility to select the most suitable package for the current month and change to another one if the transport needs change in the future. Moreover, in order to guarantee sufficient flexibility, users need to have the option to add further customization if the chosen mobility package still fails to entirely satisfy the needs (e.g. can add more taxi service,…). Finally, if the user exceeds the pre-specified "amounts" in his or her mobility

package, he or she can use the pay-as-you-go option for additional usage. (UCL London Institute 2015, S.50)

4. CHANGES IN THE TRANSPORT SECTOR

4.1 Systemic Change

In the public discourse, MaaS is often regarded as the "the biggest paradigm change in transport since affordable cars came into the market". It is being expected that MaaS will change consumers travel and use different types of transport. MaaS will completely redefine consumer ideas, moving towards a future where commuters would no longer have to rely on their own car, but have the option to subscribe to a service that gives them far greater levels of flexibility. (Cubic n.d., p.4 & p.7)

Mobility as a Service involves a shift in transportation from a fragmented system of individual service providers and private car ownership to a multimodal and holistic transportation system. (MaaS Alliance 2016, n.pag.) The vision is to see the whole transport sector as a cooperative, interconnected ecosystem, providing services, reflecting the needs of their customers and seamlessly combining different means of transport. The boundaries between different transport modes are to blur or disappear completely. (Hietanen 2014, S.1) Today, there might be several different transport providers for each city, region or country. All these transportation silos have different apps that have to be used to go around. The vision is to aggregate these silos on an operator level to a whole solution, combining these offering and allowing the customer "to roam" by using one single interface. (Kwang 2016, n.pag.)

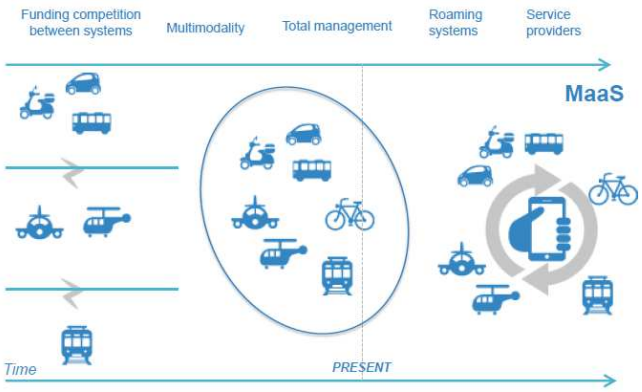

Figure 4: From Silos to a uniform solution

(Source: Hietanen 2016, n.pag.)

In order to stay competitive with the usage of private cars, public transportation needs to be able to fulfill the individual mobility needs of citizens. Since the car cannot surely be replaced with the few alternative transport modes which are currently provided, the service provision needs to be contemplated with additional multimodal services. (Cubic n.d., S.5 & Heikkilä 2014, S.12)

To set the stage, a renewed organizational framework is considered essential in order to reach efficiency gains and sustainability in the mobility sector. However, Heikkilä (2014, S.29) states that the current organization of public transport provision does not sufficiently contribute to a functional as well as convenient mobility service ecosystem.

Heikkilä (2014, S.65) suggests a possible systemic change that could take place in the transport sector. This transformation assigns to add a new level to the organization of the service provision, which is the level of "Mobility as a Service". The MaaS level would involve the provision of the transport services to the customer via an interface. The establishment of such a new "service level" requires the re-organization of the current business structures, and thus the generation of a new actor, the mobility service operators. (Heikkilä 2014, S.76)

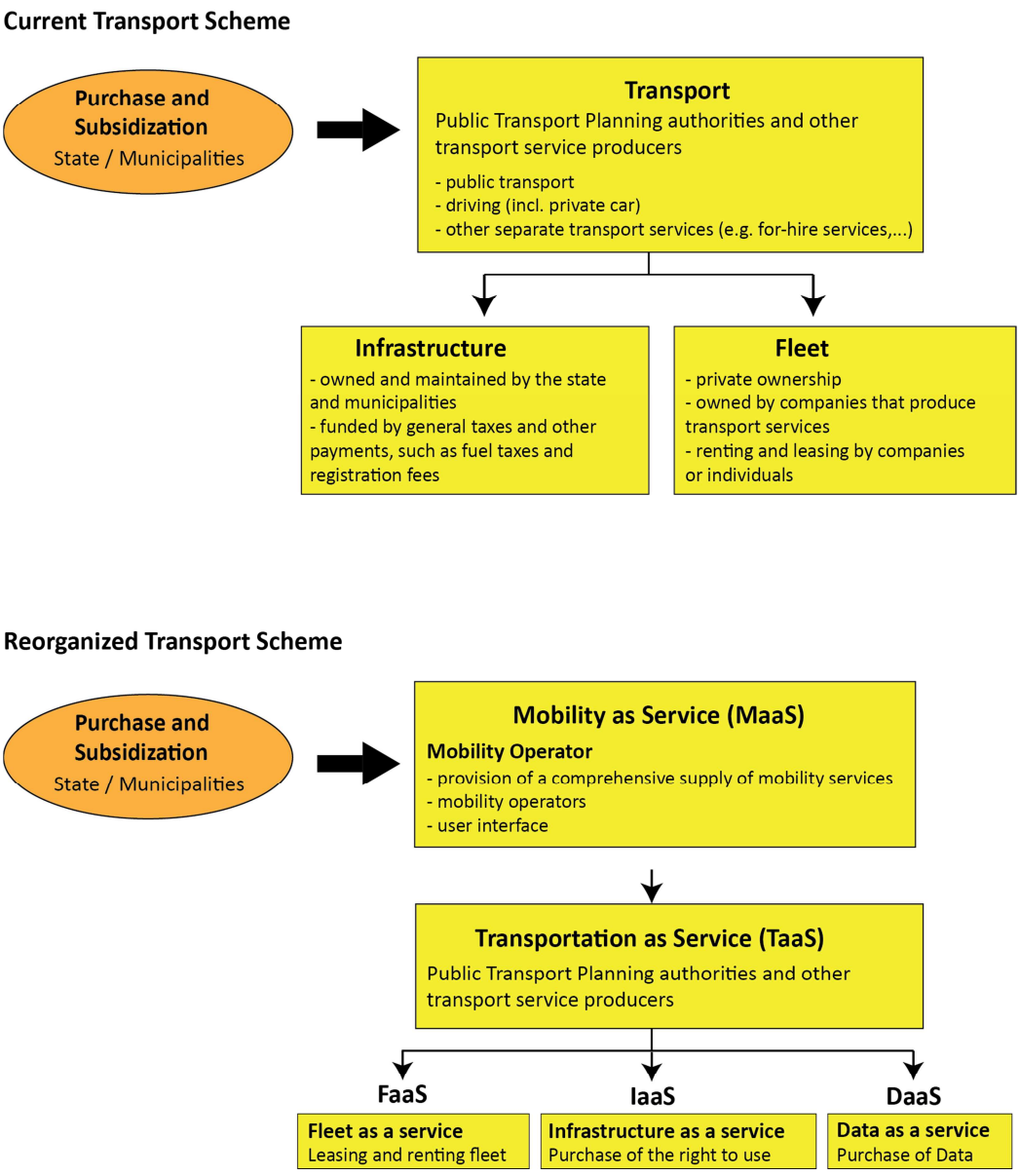

Figure 5: The transformation from the current transport service provision into a re-organized mobility service provision

(Source: Heikkilä 2014, S.65f & Hietanen & Sahala n.d., n.pag.)

The divergent, originally separated transport services would be combined into practical service supplies by the mobility operators. Hence, customers would profit from an easy accessible service supply, provided in form of complete packages. The mobility operators would be commercial and thus, have strong knowledge on user centric operation methods. In addition, they would operate on a competitive market and thus, strongly contribute to the quality of their supplies. (Heikkilä 2014, S.65)

The provision of transport services would be in a "Transport as a Service" (TaaS) Level. In this Level, transport companies would produce services and sell them to mobility operators in large amounts.

Transport services consist of service components, which are the use of infrastructure, fleet and data. As technologies evolve further on, the significance of data will increase and become an important part of the services. The latter components could also be provided as services, as that the legal rights established for their use, could be sold to transport service producers. Already by now, some transport companies, for example, lease their fleet. In this respect, the implementation of the levels "Infrastructure as a Service" (IaaS), "Fleet as a Service" (FaaS), and "Data as a Service" (DaaS) could be contemplated. (Heikkilä 2014, S.65)

Further a Revision of the purchase and subsidization procedures is vital for the transformation of the transport sector. In the current organization of the transport sector, transport services are offered and subsidized separately. Municipalities and the state subsidize public transportation through Public Transport Authorities and purchase transport services needed (such as transport for students, elderly, or disabled) directly from transport service producers. (Heikkilä 2014, S.66f &S.76)

In the transformed organization, all transportation is offered and subsidized jointly trough the Maas level, from where the funds would be distributed to the other levels. Such directing of funding would provide latitude to service operators to innovatively fulfill the mobility needs. This way, funding could also be better directed according to demand. Mobility services could be purchased from mobility operators, who might have the know-how to organize an appropriate service supply for them, as well. As these services are currently accessible only for some appointed users, through mobility operators they could be used by anyone. (Heikkilä 2014, S.66f &S.76)

Furthermore, as the subsidization of public transport currently goes directly to the Transport Authorities, it could be divided among the mobility operators. The subsidization terms could even direct the use of services and promote sustainable services. (Heikkilä 2014, S.66f &S.76)

4.2 Mobility Service Ecosystem

A Mobility Service Ecosystem is defined as a political and attitudinal environment or framework in the society which enables and promotes the generation of mobility services. (Heikkilä 2014, S.8) The ecosystem includes the transport infrastructure, transportation

services, modes, and transport information, ticketing and payment services. (Hietanen 2014, S.1) Thus, a wide range of different stakeholders will be involved, including businesses, authorities, institutions and users, each of whom play an important part in developing and delivering MaaS offering. Thus the demands of all stakeholders have to be included in the development process. (Datson et.al. 2016, S.15)

In order to establish a functional ecosystem, one of the most important factors will be getting all of the players to work together. This is essential for the sufficiency of the ecosystem, but also for the motivation of all the actors that have to be involved. (Heikkilä 2014, S.76) Cities and municipalities can create a MaaS solution that works with the transportation assets and private-sector partners available. In order to unfold and stimulate the impact of MaaS, the different Actors, be it operators, city planners, local authorities or other service companies, must collaborate effectively. Only through smart partnerships, Goals of MaaS can be accomplished to meet the current needs of commuters but also the future needs of our cities. (Cubic n.d., p.7)

Due to the sheer size of required mobility services, a scalable MaaS will be more or less implausible to materialize within one organization. The bigger the geographical area to cover, the bigger the effort of coordination gets to cover the broad variety of transport operators. Thus, a viable MaaS solution has to be based on a business ecosystem where multiple actors add services from their existing core businesses into a whole, leading to an integrated Mobility Service offer. (Holmberg et.al. 2015, p.27 & Finger et.al. 2015, p.6)

Through literature review of different approaches to describe the MaaS-Ecosystem, the following stakeholders / levels have been identified (vgl. Datson et.al. 2016, S.18ff & vgl. König et.al. 2016, S.41):

- Public Sector — Public & Regulatory Level
- Transport Provider — Supply / Providers Level (i.e. Supply Side)
- Mobility Operator — Mobility Service Level
- Customer — End-User Level (i.e. Demand Side)

The transport and business sectors, just like the rest of society, must obey the local and national laws and regulations. Hence, different authorities must be taken into account when providing both transport services and mobility services. In this particular context, "***transport services***" include all the services that are enabling the movement of people and goods from one location to another (i.e., tangible services). "***Mobility services***" comprise services (e.g., integration, brokering, ticketing, routing) that are making transportation more flexible, easier and hopefully sustainable. (König et.al. 2016, p.41)

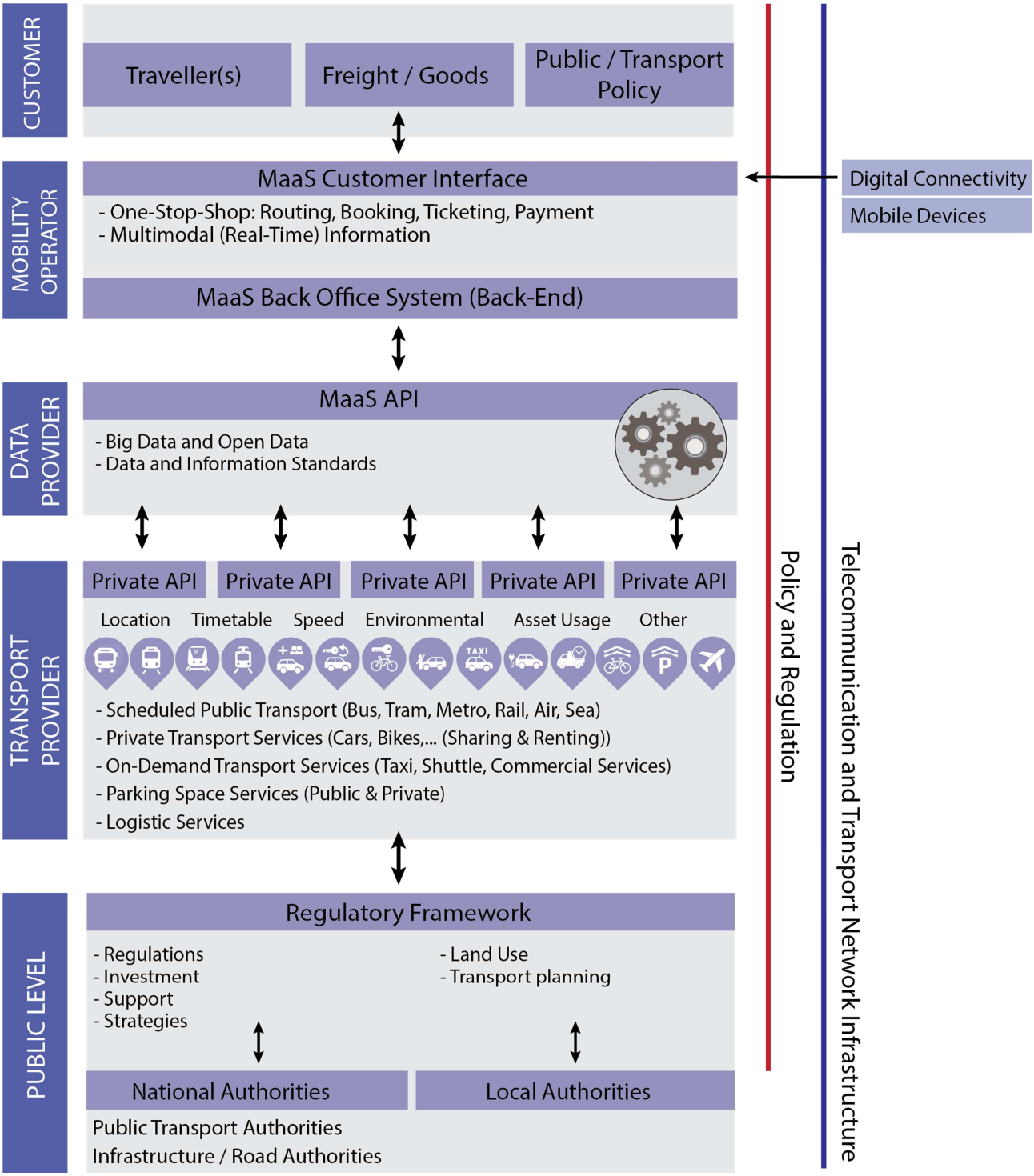

Figure 6: MaaS Ecosystem and the relations between the different stakeholders

(Source: vgl. Datson et.al. 2016, S.18ff & vgl. König et.al. 2016, S.41)

4.3 Roles and Needs of different Stakeholders

4.3.1 Public Sector

When it comes to regulation and legislation, Public authorities are vital in the transition from the present system to a service ecosystem in mobility. The roles of policy and regulation are important as they can shape how MaaS meets the needs of society. Through smart regulation, the public sector should act as an enabler imposing the frame conditions that affects the potential of different transport modes. This refers to the regulatory framework, support programs for standardization, as well as target-oriented planning instruments, as well as the execution of pilots, in order to develop practical knowledge and experience. (Heikkilä 2014, S.67 & Hietanen 2014, S.3)

The VDV (2013, S.10) states that each governmental level (cities, municipalities, federal governments, and the EU) is challenged to contribute to the establishment of a service ecosystem by clarifying common objectives and concrete measures. (Heikkilä 2014, S.67 & S.75) Policy Areas can be made effective through political leadership tactics such as regulation, incentivizing, negotiation, facilitation and collaboration. (Datson et.al. 2016, p.22)

Therefore, the legislative framework should be revised in order to remove legislative obstacles blocking fair market conditions and the entrance of new players to the markets. (Heikkilä 2014, S.76) Moreover, the focus of regulation should be ensuring transparent market conditions and fair market performance, all while securing the legal position of the user (as a consumer), instead of technically-focused and detailed regulation of individual transport modes. In some cases, deregulation should be considered. Appropriate data policy is a crucial catalyst for progress. (Hietanen 2014, S.3 & König et.al. 2016, p.41f)

The roles of policy and regulation are important as they can shape how MaaS meets the needs of society. Datson et.al. (2016, S.22) name the following indicative policy areas that could be used to affect how MaaS will be delivered, trough political leadership tactics such as regulation, incentivizing, negotiation, facilitation and collaboration.

4.3.2 MaaS Operator

At the center of the architecture are the actors that make MaaS feasible, tangible and visible in terms of its technical functionality (e.g. transport services and data transfer), and its outputs (e.g. the customer-interface and its features). (Datson et.al. 2016, p.23)

Most of the participants are more or less the same stakeholders as have previously existed in the transport sector. In practice, the MaaS Operator is the only new stakeholder in the value chain, according to the approach suggested by Heikkilä (2014, p.65; Chapter 4.1) to add a new level to reorganize the transportation sector.

The Role of the MaaS Operator is to be the player whose core business (objective) is to scale and grow MaaS. The Mobility Service Operator combines the existing transport services into a single mobile application on the “one-stop-shop” principle and provides personalized

transport plans tailored to the different customer needs. Thus he is responsible for customer service and user experience. (König et.al. 2016, p.42 & Goodall et.al. 2017, n.pag.)

It is only uncertain which sector would be appropriate to fill the important integrative function of the mobility operator, and setting up and managing a mobility platform. Besides the existing public authorities, also new private operators could be seen as potential mobility service operators. (König et.al. 2016, S.42)

Finger et.al. (2016, S.6) state that establishing an ecosystem for mobility alliance operations demands pioneers that are able to implement the renewed system. However, at least in the beginning, there will be the need for a strong role of the state for providing a certain level of services. Therefore, Transport companies and associations, in cooperation with municipalities, seem to be qualified to adopt the leading role in this transformation by providing the necessary primary system and organizational center stage. (VDV 2013, S.5)

The first option stresses that existing transport service operators or regional transport agencies could start to be potential integrators of transport modes and thus suitable mobility operators. UITP (2016, S.6) recommend Public Transport to take an active role as Operators, since they are already organizing and managing multiple public transport modes – trams, subways, local trains, buses. However, to become a full-scale MaaS operator, emerging demand-responsive mobility services have to be integrated as well to ensure greater flexibility. (König et.al. 2016, S.42)

With the new service offering, traditional public transport networks/operators can benefit in two ways. On the one hand, establishing mobility operators makes it easier to use public transport as part of the value chain. On the other hand, some public transport operators can become the operators of new mobility, giving the chance to look at their strategies in a new light, which might happen anyways, sooner than one might expect. (Hietanen 2014, S.3)

Further, regional transport companies and public transport associations could be in charge as mobility operator. Since their original core business is to provide, organize and integrate mobility services, they already dispose over the necessary good qualifications and experiences to take over the role of the mobility operator in its whole complexity. In addition, these institutions bring a ready-made broad customer basis as well as the assets of regional and local knowledge as well as intense linkages and access to other local stakeholders, politics, and the administration. (VDV 2013, S.10f)

The same arguments can be applied to other incumbent transport companies to play a crucial role in the development of integrated mobility service offers, having the necessary experience and knowledge, and bringing the necessary critical mass of customers to roll out such systems. (Finger et.al. 2015, p.7f) For instance, Rail-Operators are already experimenting with different forms of intermodal offers. In fact it is part of the business strategy to expand in different transport modes and develop into true “mobility providers”. For example, the incumbent rail operator in Germany (*Deutsche Bahn*) and France (*SNCF*) have already been extending their activities outside of the railways to the point of urban car- and bike- sharing provider. (Finger et.al. 2015, p.6)

Another option is the rise of external, independent operators, entering the market by making deals (e.g. bilateral agreements) with transport providers and starting to sell different kinds of service packages to the customer. This would likely require extensive marketing and a great value proposition, since new MaaS Operators do not usually have an existing customer base. On the other hand, an external and independent actor does not necessarily have precious commitments in any direction – as existing transport operators may have – and hence they can arrange new service combinations, as they seem appropriate. However, if the local / regional transport is organized by the local authorities – as it happens to be in many cases – MaaS operators are in reality forced to collaborate with them. (König et.al. 2016, p.43)

Especially car-manufacturers as well as transport providers (railways or airlines) that are active players in the transport market have the capabilities to develop such platforms while allowing the necessary openness to other providers to be integrated in them. In Addition, the number of newcomers of the private-sector, seeking to fill the gaps in local transportation services, may have a keen interest in mobility platforms. Here, especially the start-ups for demand-responsive mobility services (e.g. Uber) could be suitable to adopt the role of the operator. (Goodall et.al. 2017, n.pag.)

The efforts of the automotive OEMs and public transport operators to provide MaaS may be complemented by new entrants from outside the transport sector. Examples of potential external operators players that are completely outside the transport sector could be Telecom- and Internet provider, software companies (e.g. Google, Apple etc.) as well as retail and media organizations with a strong track record in service provision and access to a large customer base may invest in MaaS. (Datson et.al. 2016, p.30) In Finland, the telecom operator Telia Sonera is currently developing a conceptual MaaS-service, in cooperation with several partners such as cities and regional traffic operators. (Holmberg et.al. 2015, S.16) Moreover, many retail companies, basically completely independent and outside the transport sector, already offer mobile communications contracts and could thus also extend their offering to become mobility operators of tomorrow. (Flügge et.al. 2016, S.228) Another example are booking platforms or transport agencies where currently a high share of airline tickets are sold indirectly; this platform-based services could also be extended to mobility services. (Finger et.al. 2015, p.7f) Think Expedia, but for getting around the city. (Lorinc 2016 , n.pag.)

4.3.3 Data Provider

The data provider is one of the intermediary layers between the transportation operator and the end user. It manages the data exchange between the multiple service providers, providing the application programming interface (API) gateways and analytics on usage, demand, planning, and reporting. Because individual service providers are not likely to share their app data, having a third party involved can remove some of the barriers with cooperation that would otherwise arise. (Goodall et.al. 2017, n.pag.)

The Data Provider offers data and analytics capabilities. This includes processing, repackaging and publishing data from a range of sources including open data and private data.

(Datson et.al. 2016, S.24) The data sources will vary depending on the requirements of the MaaS Provider but are likely to include e.g. available route(s), pricing information, localization etc.

The data, collected from various sources, is shared via Application programming interfaces (API), a set of procedures and tools for building software applications that interact with the features or data of another application or operating system. Data sources may vary depending on the specific requirements of the MaaS Provider, but are likely to include at least the available route(s), pricing information, real-time asset and vehicle position and some more. (Datson et.al. 2016, S.25)

4.3.4 Transport Provider

Essential to any MaaS offering are its largest players, the public transportation operators. Demands to expand service delivery have driven many transportation agencies to introduce new modes of travel. These are typically taxi companies, car sharing companies, bicycle sharing companies and other mobility service providers who can contribute to an attractive solution for customers mobility needs. (Holmberg et.al. 2015, p.27) Furthermore, Transport Operators can also include airlines, highway authority assets, freight carriers, parking operators, electric vehicle charging infrastructure owners or petrol filling station owners. Individual citizens who wish to share their own vehicles by offering them as a service through the MaaS Provider are also considered within this category. (Datson et.al. 2016, S.25)

Gaps in public transportation services have fueled a growing army of small-scale private providers, each offering a specific service: parking, carpooling, peer-to-peer car clubs, ride-hailing, or on-demand bus rides. Typically, each operator requires its own app, with a separate interface and payment mechanism, and each service maintains its own customer relationships. (Goodall et.al. 2017, n.pag.)

The Transport Operators share (via API) data collected from a range of sources, including potentially crowdsourcing activities. Transport Operators may choose to install sensors to meet the requirements of the Data Provider and MaaS Provider. (Datson et.al. 2016, S.25)

4.3.5 Customer

Mobility Consumers (mobility users) are the users of the mobility services, and are very diverse. The consumers range from individuals to organizations or to groups such as travel groups or families. On the organizational side, companies as well as public administration use mobility services. Other consumers are secondary and tertiary consumers. (Flügge et.al. 2016, S.64 & S.74)

- **Travellers**, with variations in personal mobility needs
- **Freight**, customers using MaaS to send and receive goods

- **National and local government**: A key customer in terms of MaaS helping them achieve policy objectives and providing travel pattern insight. The public sector may also be a customer in terms of procuring speciic MaaS capabilities.

It is important to identify the needs of different target customer groups within the consumer domain; these needs will be designed for and exploited by the MaaS Provider. (Datson et.al. 2016, S.20)

4.3.6 Infrastructure and Software

The requirements in terms of connectivity and capacity of mobile data networks are becoming much higher in a system that makes use of the Internet to a much larger extent. Therefore, intelligent and connected infrastructures are vital elements in turning MaaS into a reality. To work effectively, MaaS would require the following conditions: widespread penetration of smartphones on 3G/4G/5G networks; high levels of connectivity; secure, dynamic, up-to-date information on travel options, schedules, and updates; and cashless payment systems. (Finger et.al. 2015, p.8 & König et.al. 2016, p.41)

To enable these conditions, a diverse range of actors would need to cooperate, in order to establish enough support to foster the development of physical and digital infrastructures for such an interconnected system. Obviously, there are many stakeholders providing from supportive services or technologies (e.g. mobile ticketing and routing algorithms) to mobility service providers / operators to make their MaaS services possible. (König et.al. 2016, p.41)

There should also be a thoughtful integration of physical infrastructure that enables transfer between transportation services, such as bus and subway interchanges, or bike- and car-sharing spaces at stations. Transportation planners should think through how the various modes link up. (Goodall et.al. 2017, n.pag.)

To make all the service available to the end-user, an easy-to-use interface must exist, such as mobile applications combining transport and mobility services. Open interfaces (API, application programming interface) further accelerate the emergence of new and innovative services that can reach substantial global markets. (König et.al. 2016, p.41)

The Customer Interface provides the communication link with the customer and supplies a range of features that support the value proposition. These features may include providing the customer with the ability to purchase mobility, receive personalized and contextualized information on which to make real-time travel decisions and allow customers to provide feedback to the MaaS Provider. Data flow between the Customer Interface and the Back Office System is enabled. This can provide journey planning, transaction and payment, billing and usage information. Intelligence designed for the customer is made accessible via the Customer Interface. (Datson et.al. 2016, S.23)

4.4 MaaS Business Perspective

4.4.1 What does Mobility will look like for customers?

Mobility as a service will create a new model for how we buy travel opportunities. Travel services and features will be purchased using service contracts. Season tickets will disappear and fares will instead be paid for on pay monthly or pay as you go service contracts with bolt-on extras available to users as needed. (Burrows et.al. 2015, S.29)

For a long time, transport has been sold with a "production based approach" and no significant service layer has been developed. A sector that focuses entirely on service distribution and developing customer friendly offers does not yet exist for transport but does for telecommunication. (Finger et.al. 2015, p.4) Mobility as a Service (MaaS) stands for this transition to a more significant service provision, focusing entirely on service distribution and developing customer friendly offers. A new service layer is being developed, where a consumer buys in mobility, instead of investing in transport equipment. (Finger et.al. 2015, p.5) The MaaS-Concept is taking its inspiration from the structural changes that have occurred in the telecommunications sector following its liberalization over the past several decades. (Fountain 2016, n.pag.)

The vision is to offer mobility in form of bundled packages rather than as individual services. This business model can be compared to "subscription-based"-services such as Spotify or Netflix, taking their inspirations in the way telecommunication services are offered at present. (Finger et.al. 2015, p.5)

- **Pay monthly and pay as you go options** for travel – catering for all types of travelers, be they daily, occasionally, or simply visitors;
- **Different service contracts (Packages)** will be used to target particular types of users such as commuters and students;
- **Bolt-on extras** will be easily available to supplement your service contract such as additional bike rentals, peak time trains or car club access.

These monthly service contracts could be developed further and as well be used to incentivize particular behaviors such as the time or mode of travel. They could even be tailored to promote active travel which could be supported by public health funding. Likewise air quality and public health funding could support zero emissions transport over any form of polluting mode. (Burrows et.al. 2015, S.21)

What is being used is a situational choice. You use MaaS without knowing beforehand where and when to go. Anything on top of the subscription fee would be paid in addition. (Flügge et.al. 2016, S.214) It can be compared to reading a newspaper: the reader chooses and selects what he is reading. The platform for MaaS operations works quite similar. You can skip and choose what kind of MaaS components you like to use". (Flügge et.al. 2016, S.214)

From the perspective of the Finnish Intelligent Transport System (ITS-Finland), mobility packages are priced on the basis of the following criteria and are offered in four service

variants, thus giving an exemplar representation of possible mobility packages. (Flügge et.al. 2016, S.217)

Figure 7: Example of a Set of Mobility Packages, suggested by ITS Finland

(Source: Hietanen & Sahala n.d., n.pag.)

4.4.2 What does Mobility will look like for Providers and Operators?

The Business perspective of the MaaS-Concept is already very present, being an important factor in getting actors to participate in the elaboration of Mobility as a Service. Not only does the MaaS approach pursue the achievement of transport policy objectives, it also offers a profitable business model, come about from very significant business opportunities. (Finger et.al. 2015, S.4 & Russ, Tausz 2015, n.pag.)

The enormous market potential of MaaS is seen as an important business dimension of this development. After housing, mobility currently is the largest expense of an average family. For example, the money that is not spent on cars becomes available for other mobility services. For an operator who takes care of all the transport needs of the consumer, the average revenue per user (ARPU) is potentially high. (Hietanen 2014, S.3)

It has to be calculated including the amount that a car-owning household currently spends on taxes, fuels, road charges and acquisition costs of a car. Here a budget depending on the household, of between 300 and 600 € monthly is not unrealistic. However, it has to be clarified that the Market size or customer behaviors have not been proven so far. (Finger et.al. 2015, p.5)

The development of Mobility as a Service is about building on a viable business model, which is something that an Operator has to have in order to offer a sustainable service. "*The business idea is neither to integrate information systems, nor offering seamless information to support intermodal trips. It's not even about integrating payment systems in order to offer tickets in the phone. The business idea of MaaS or more about procuring everyday travel in volume and repackage and deliver it in an easy, flexible way*". (UbiGo 2013, n.pag.)

Thus, Mobility operators will most likely change the logics of the rest of the value chain as they will make service provision a business. Currently, in most countries mobility is provided by public transport associations. In the renewed system, mobility services would be provided by institutions (the mobility operator) operating as supplier. (Figure) The service supply would be provided through convenient mobility service portals (the interface), operating as an interface between service producers and customers and manage the service supply and charging procedures.

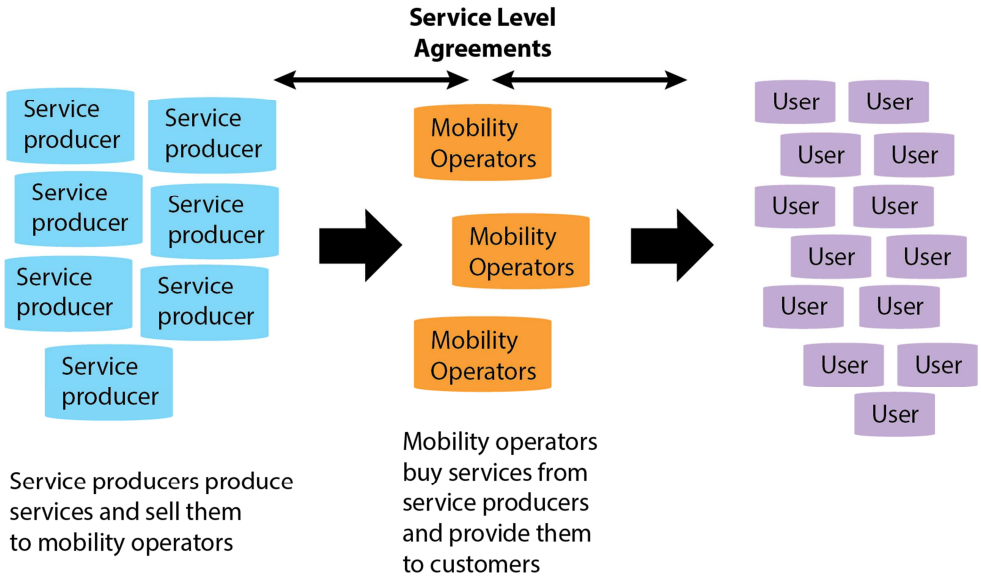

Figure 8: Mobility service provision, in the form of MaaS

(Source: Heikkilä 2014, S.71)

The operator makes contracts (service agreements) with various producers of mobility services (transport providers) as well as with the customers. One MaaS service can include different service agreements, be it the contracts with the providers or the packages offered to the user. (Heikkilä 2014, p.71)

The identified service agreement types are re-sold services and negotiated services. While Re-sold services can be based on list fares or on fixed reduction percentage, Negotiated services are based on bilateral agreements, e.g. between the Mobility Operator and different Transport Providers. These bilateral service agreements between Operators and service providers or customers can vary, with conditions and suppliers depending on the local context. (König et.al. 2016, p. 65)

SERVICE AGREEMENTS		
Re-Sold Services		Negociated Services
List fares	Fixed Reduction (%)	Fares depend on bilateral agreements

Figure 9: Different types of Service Agreements

(Source: König et.al. 2016, S. 65)

The funding for the services is expected to be generated from the User. To create a viable business, making the product attractive for the target group is a requirement. Service provision would be made attractive, for instance, by providing individual services, packaging services according to customer desires, informing and marketing. Every actor delivers a certain value to provide a viable service system that supports the delivery of MaaS, resulting in finished goods, the integrated mobility service, which the customer can purchase. (Heikkilä 2014, S.71 & Hietanen 2014, S.3)

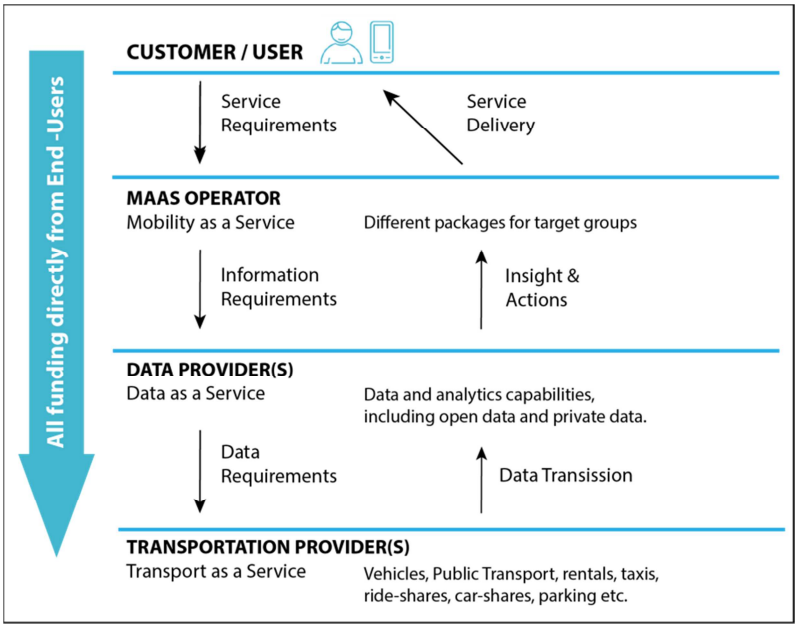

Figure 10: Transport Systems will become consumer business

(Source: Datson et.al. 2016, S.15 & Hietanen et.al. n.d., n.pag.)

Therefore, a broad base of customers is needed as an important source for revenue for the service providers. It may be challenging for Transport Providers or MaaS Operators to offer value propositions that are more attractive to customers than the private car. However, given the size of the mobility market and diversity in consumer travel requirements, there is significant potential for the MaaS Provider to attract customers. (Datson et.al. 2016, p.30 & Holmberg et.al. 2015, S.39)

Taken together, the different actors form a value chain, offering different value propositions to their partners and profiting from different revenue streams. The procured services will be packaged and distributed individually to the customer, including payment for the used services. Hence, customers may profit from an improved and more affordable provision of mobility. Service providers profit from increased ticket returns through proliferated business, as well as an eased access to a broad customer base and thus more effective introduction of new mobility services. (Figure) (Heikkilä 2014, p.12 & p.71)

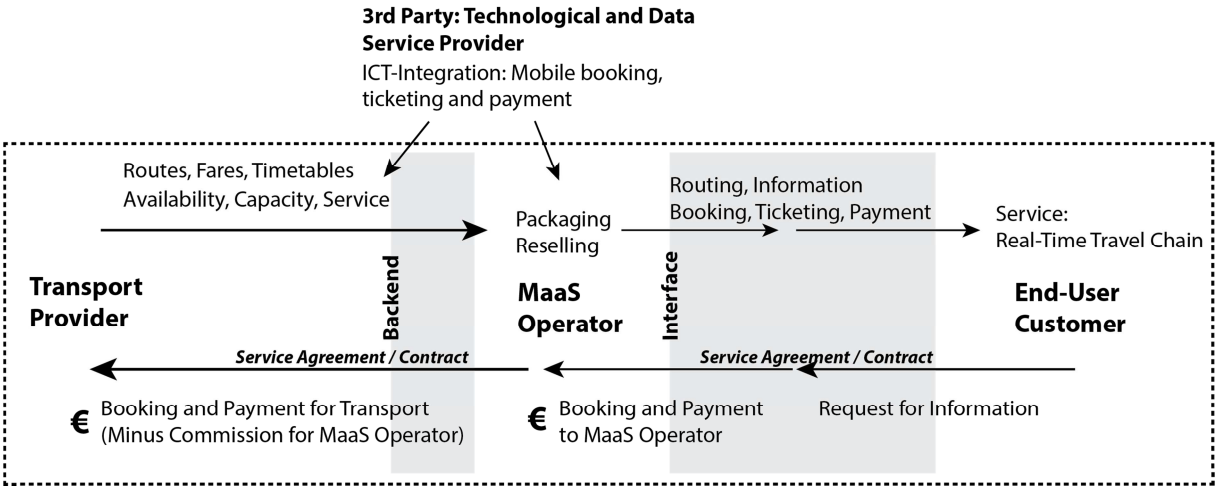

Figure 11: Value Propositions and Revenue Streams

(Source: König et.al. 2016, p.41)

It is expected that the generation of more than one operator may result in an increased competition, leading to prices that more accurately reflect operations costs, service improvements and efficiency gains. That is, affordability of mobility services would especially be achieved through economies of scale. (Heikkilä 2014, S.80) Once the system becomes more established and a critical mass of customers will be achieved, more choices and price models will become available, and mobility services could be offered at affordable rates with different "packages" according to customer preferences. (Finger et.al. 2015, p.4f)

However, this would imply that in the beginning the focus will rather be on wealthy customer groups that are able to afford the possible "mobility packages" in the first place. On the other hand, the most important demographic that was identified as being open to new mobility trends were young urban people, who are not known for their spending power. (Finger et.al. 2015, p.5) Simultaneously, mobility prices would decrease in city centers and increase in areas with lower density. However, people living in city centers are also generally wealthy, whereas people living in periphery might not be. Thus, such pricing could result in an unequal provision of mobility access situation. To alleviate these issues, an allocated subsidizing from the public sector might be appropriate to support the deployment of MaaS. (Heikkilä 2014, S.80)

Further, an open market and functioning businesses are needed. It would be useful to discuss the ending of government ownership of transport service producing companies in order to maintain balanced competition, especially in areas where multiple modes of transport already co-exist and compete for consumers´ attention. (Heikkilä 2014, S.76) The challenge is to get the local and regional public transport authorities to open up public transport for resellers, allowing Mobility Operators to include public transportation offerings based on the travelers' profiles. (Flügge 2016, S.215)

This would imply moving certain powers away from the transport providers to new actors. (Finger et.al. 2015, p.6), including the rescission of the public transport ticket sales monopoly of the Transport Authorities, so that other companies may also begin to sell public transport

tickets.(Heikkilä 2014, S.76) Even though the MaaS-operator takes full responsibility towards the providers and the customers, the public transportations´ brand and image are important as they are being recognized when MaaS consumers are on-board. (Flügge 2016, S.215)

4.4.3 MaaS Business and Operator Models

Basically, 2 variations of the MaaS operator business models and revenue streams have been identified: the agency model and the merchant model.

The **agency model** is primarily based on reselling, where the MaaS operator procures everyday travel volume (i.e. transport tickets) in a significant volume and receives some volume discount. The operator repackages the travel services for the customer, disconnecting what the operators pay for the trips from what their customers will pay. The marginal profit is generated by the MaaS operators by reselling the tickets at the normal price. Therefore, the reseller model (also referred to as concession model) needs to ensure that the MaaS-Operator receives a fair margin for the reselling of public transport services, and that the users pay in average as much as the direct customers of public transport. It is supposed that this seems to be the only way to generate enough revenue for a platform provider to sustain. (König et.al. 2016, S.63 & Flügge et.al. 2016, S.215)

In the **merchant model**, an open market exists via a platform, with various transport providers offering their services, where the user can "shop" around for each trip to the current prices. Profitability rests upon commissions that the transport operators are paying to the MaaS operators for reselling the services to the customer, by taking a percentage on each transaction between a customer and a provider. (König et.al. 2016, S.63 & Flügge et.al. 2016, S.215)

These two options are not mutually exclusive and can be used simultaneously. Probably mass product articles, such as public transport tickets, where volumes are large and demand is assured can be sold using the agency model, while more exclusive and individual transport modes (e.g. rental cars) are best sold via the merchant model, which fits situations where volume is small and demand is hard to predict, but commissions will be higher. (König et.al. 2016, S.62f)

As potential Operator Models have been identified the Reseller- and the Integrator-Model as the main commercial business models. Further, the role of public transport as MaaS Operators and more extended and flexible Public Private Partnerships have to be considered.

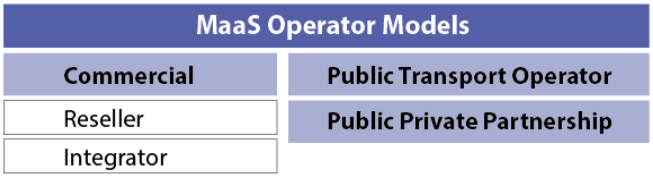

Figure 12: MaaS Operator Models

(Source: König et.al. 2016, p.63)

In the **Reseller model** *(Figure 14)*, a Reseller offers multiple services from different transport service providers (***TSP***) to the customers, using a specific interface. A travel agency is a good example of a Reseller.

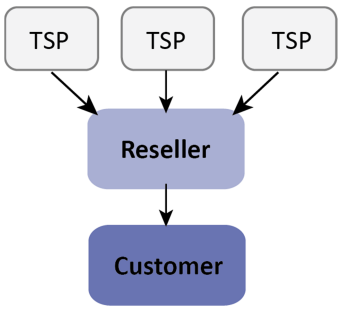

Figure 13: The Reseller-Model

(*Source: König et.al. 2016, S.64)*

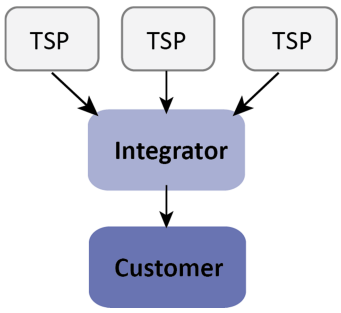

Figure 14: The Integrator-Model

(Source: König et.al. 2016, S.64)

The **Integrator model** *(Figure15) includes* an additional mobile service provider (***MSP***) that provides key enabling technology and services (e.g. travel planning, mobile ticketing and payment). In this model, some operators provide MaaS as main business (e.g. for example MaaS Finland has been established for the MaaS operator purpose), while some other operators include MaaS as a (business-) complement to their service offering (e.g. Telecommunication Companies, whose core businesses are telecommunication). (König et.al. 2016, S.64)

In the **Public transport operator model** *(Figure 16)* the role of the MaaS operator is taken by Public transport operators, integrating additional transport services (e.g. taxis, carpooling and city bikes with public transport) with their existing public transport. Digital services can again be provided (e.g. mobile ticketing and payment) provided by a mobile service provider (MSP). The Public transport operator may be owned by the municipality/region (e.g. Transport Companies, WienerLinien, …), or owned by the state (SNCF in France or DeutscheBahn in German). The Public transport operator model could be mainly used in cities where comprehensive public transport already exists. (König et.al. 2016, S.64 & S.67)

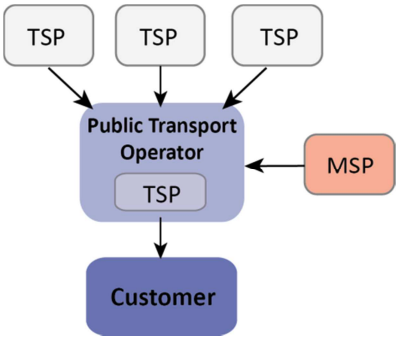

Figure 15: The Public Transport Operator Model

(Source: König et.al. 2016, S.64)

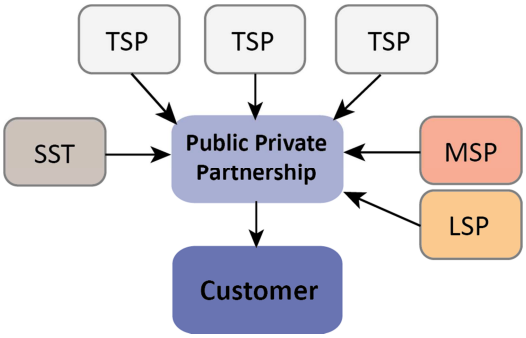

Figure 16: The Public-Private-Partnership Model

(Source: König et.al. 2016, S.65)

In the **Public-Private-Partnership (PPP)** *(Figure 17)*, the public actor may integrate different types of actors and services in the system (e.g. private companies, municipalities and transport operators), which will rationalize the services the public actor is responsible for. These may include legislated special transport services and freight/delivery. In addition to transport and mobile service providers (***MSP***), logistics service providers (***LSP***) may be included. Organizations responsible for statutory social service (***SST***) transportation, related e.g. to disabled and elderly persons, collaborate with MaaS operator. (König et.al. 2016, S.64)

The PPP-Model could be especially suitable in rural or sparsely populated areas where combining logistics services as well as school and statutory social service transportation with MaaS is important for efficiency and maintaining an appropriate service level.

All operator models can include logistics services and other additional services. However, the PPP model usually integrates logistics services from the beginning due to free capacity in transportation and long distances. Other operator models more likely start with mobility of people, and later on integrate freight and other additional services. (König et.al. 2016, S.65)

5. BENEFITS AND GOALS OF MAAS

5.1 Benefits of Mobility as a Service

Overall, Mobility as a Service is expected to provide manifold benefits for both, the users, the public sector as well as for the business sector. (Dotter 2016, n.pag.) Services are a lot easier to optimize than several million peoples' individual behaviors, and since costs and environmental impacts are actually correlated in transportation, service providers will have the financial incentive to do this optimization in a way that will mostly benefit the environment. (Fitz 2014, n.pag.)

5.1.1 Benefits of MaaS for Users

Easy access to integrated mobility solutions: personalized mobility-based services, reflecting the users' specific needs. MaaS is meant to provide users easy access to a variety of transport services, with a strong user orientation, high-service quality and competitive pricing. (Dotter 2016, n.pag.)

Generation of globally scalable Door-to-door mobility services with a better level of service than private cars. It would mean the ability to easily compare and contrast the information and fare rates from a range of transport services, thus enabling a more flexible travel. This allows users to plan a seamless, multimodal journey, without having to book and pay for each leg of the trip separately. This would increase personal flexibility and improve travel experience. By adding more variability into the supply side of transportation, MaaS could generate a more pliable transportation system, offering the same flexibility than the car. (Cubic n.d., p.5 & Heikkilä 2015, n.pag. & Goddall et.al. 2017, n.pag.)

Reduce the need for owning a (second) car. By making journey planning and experience much more convenient for users to get round, MaaS aims to substantially provide the same or even a better level of convenience than the private car. Since there will be easier access to more alternatives, users will more likely opt to give up their personal vehicles for commuting, not because they´re forced to, but because the alternative is more appealing. (Goodall et.al. 2017, n.pag. & Hietanen 2014, S.1f))

Cut Costs for the User. Besides making consumers' travel hassle-free, MaaS offers a more affordable way for citizens, families and tourists to move around. Personalized and situation-specific use of transportation means leads to a more efficient use of time and money. Mobility expenditure channeled through MaaS Providers (fixed prices and transport fees) may provide cost savings for the customer. They only pay for the trips they actually make. (Datson et.al. 2015, p.17)

A better competition between providers would lead to a decrease of transportation costs and open up new affordable alternatives for the user, thus removing car-ownership-related burdens (e.g. responsibility of maintenance and storage) from the user. (Hietanen 2014, S.1f)

Encouragement of more sustainable travelling habits. MaaS could guide or incentivize users to make their trip in the socially most responsible way. The user could be rewarded for choosing the greenest trip possible, all while ensuring a high standard of moving and living. (Cubic n.d., p.6)

Supporting more active and healthier living. Just as well, mobile interfaces could be tweaked to encourage healthier choices, such as walking or cycling. Additional value can be generated, i.e. by using health spending to support traditional transport interventions such as encouraging active travel. (Burrows et.al. 2015, S.25)

Improving Accessibility by the integration of the First / Last Mile. All while reducing car ownership, the integrated approach of MaaS may improve accessibility by solving the recurring problem of solving the first mile/last mile problems. MaaS offers transport services improving the access to transit stops across their service area by removing barriers found in the first and last mile. (Sisson 2016, n.pag. & Williams 2017, n.pag.)

Improving access to opportunities: With the ability to enable individuals to make better choices about how to move, MaaS can also help provide more and better opportunities to particular transport requirements. A lot of specific mobility requirements do not easily fit with the commercial supply of scheduled, fixed transport services. A Lack of access to mobility can have significant direct and indirect costs to employers, to healthcare providers, to education providers, and ultimately to the public sector and society as a whole. By improving the access to health, education and employment, MaaS will fit into a much wider social requirement where significant (financial) savings could be made. Additional public services and benefits can be integrated into this model, for example helping people into employment through subsidized journeys to interviews (Burrows et.al. 2015, p.23ff)

Improving social inclusion, thus reducing of isolation. An integrated approach using MaaS offers new, flexible opportunities to connect isolated communities with the public transport

network or serve major trip generators such as schools or hospitals directly. In more isolated areas where the demand is not sufficient, traditional transport thinking and planning often fails people and communities. Through MaaS, mobility opportunities may be available for everyone, be it the ageing population, users with specific requirements that cannot be easily met by traditional transport interventions or people living in more isolated areas. (Burrows et.al. 2015, p.23f)

5.1.2 Benefits of MaaS for the Public Sector

Support of Policy Goals: MaaS is considered to benefit policy makers by offering the potential to support political commitments through the more effective achievement of transport policy goals, such as tackling congestion issues, reducing car-ownership, improving network efficiency, decreasing pollution or even enabling economic growth. (Datson 2016, S.34)

Improving policy decisions: MaaS will help city authorities glean important information from multiple sources to make better informed policy decisions on evolving mobility issue. The information could be used to learn where to improve infrastructure for people and how to redesign and update the travel systems while optimizing capital spend - it's invaluable insight to help make the city more livable and enjoyable. (Williams 2017, n.pag.) For instance, data can help cities to advance their transportation systems and to close coverage gaps or help reroute demand to assist those portions of the transport network, which are struggling the most. (Xerox Corporation 2017, n.pag.)

Saving public money by a more efficient allocation of resources: The traditional policy responses to urban mobility challenges – to build more roads and expand public transport—are too expensive for the cash-strapped times. (The Economist 2016, n.pag.) The MaaS-Approach offers the potential for cities to save public money and to offer a larger array of services using the same or reduced levels of funding. (Goodall et.al. 2017, n.pag.)

Increase the efficiency of the whole transport system. Through an advanced data deployment, there will be an improved anticipation and management of traffic incidents, more flexibility in the event of congestion as well as a higher resilience in the event of major disruptions. (European Commission2014, p.3) Thereby it will be easier to increase the efficiency of transport operations and transport networks as a whole and *thus increasing the attractiveness of Public Transport.* ((Bouton et.al. 2015, n.pag.)

Just as well, the integration of all transport services into a single platform could help address the issues of overcrowding and congestion. (Cubic n.d., p.5) As travelers could be influenced and encouraged to travel during short (peak) periods of the day, congestions at peak hours could be reduced. (Burrows et.al. 2015, S.25 & Goodall et.al. 2017, n.pag.)

Increase of the efficiency and attractiveness of public transport as a whole. By the prediction of user-demand in real-time, the use transport capacity could be optimized by matching demand dynamically with the available capacity. (Bouton et.al. 2015, n.pag.) A

fully digitalized transport network provides real-time updates and lower costs for operators as resources are used when and where they're needed. There will be no more empty buses running around streets and villages as demand will be known before the vehicle leaves the depot. (ITS International 2017, n.pag.)

Mitigation of Peak-Traffic Issues. A more efficient use of capacities and more efficient dealing with traffic incidents may also help tackling peak traffic issues. MaaS may lead to an improved commuting experience especially during peak hours, offering more flexible travel services. (Buscher et.al. n.d., S.6) Therefore, incentives such as dynamic pricing could be deployed to encourage users to avoid peak time services and spread demand over a wider period of time. Dynamic Prices could be influenced, at varying degrees, by the basis of supply and demand (a pricing model already offered i.e. by Uber). (Burrows et.al. 2015, S.25)

Reduction of the amount of Cars in Cities. As urban density continues to grow, MaaS could be contributing to the goal of lowering the need for private cars and thus decreasing the traffic volume, by providing alternatives to move more people and goods in a way that is faster, cleaner, and less expensive than current options. The goal is to have fewer cars on our streets. Since one cannot always move without the car, the goal should be to achieve as little car as possible and as much as necessary. (Verkehrsclub Deutschland 2013, n.pag.)

Decrease of pollution. The reduction of traffic volumes would not only largely reduce congestion, but also tackle environmental disadvantages. Fewer cars on the streets idling in traffic jams would mean decreased emissions of greenhouse-gas emissions (GHG), pollutants and less noise, and in a wider perspective, reduced economic loss as people get to work on time as well as even more consumer trust. (Cubic n.d., p.6)

Make cities more livable. Such perspectives would additionally make way for urban transformation, giving the potential to help cities to make its city-centers car-free - not by banning them, but by building a transport system that renders them redundant. Less space has to be dedicated to vehicles and parking and thus more to walking and cycling—cleaner air, more development options and larger parks and green spaces. (Gleave 2016, n.pag.)

5.1.3 Benefits of MaaS for the Economy

MaaS has the potential to make a significant contribution to the service sector, by generating jobs and economic growth. The Improvement of Transport efficiency may help business, employment and vitality thrive, driven by new market opportunities that will support peoples mobility and lifestyle needs. (Datson et.al. 2016, p.17 & p.28 & Dotter 2016, n.d.)

MaaS will offer a profitable market for new transport services, by leading to the Creation of an innovative and open (eco)-system for Intelligent Transportation Services that can easily be entered. By the rapid deployment of innovation and modern technologies, MaaS represents an emerging business involving several side businesses (e.g. by linking transport with other services), opening new profitable markets for new services. Thus there will be market growth and additional revenues. (Dotter 2016, n.d.)

Businesses would also be able to take advantage of this improved understanding in order to improve their asset management, scheduling and routing, or even staffing. Further, there may be a more reliable organization of business travel, supporting the reduction of time loss. In addition, Suppliers to the sector would be able to target products and services that could create real value for operators. (Burrows et.al. 2015, S.25)

It will be important to adapt mobility services to the local market and local infrastructure. The rapid development of new technologies and the evaluation of data will influence the future of mobility in an intelligent way, as will the development of autonomous vehicles. All these changes will open up more opportunities for customers and businesses. (Oliver Wyman Group 2017, n.pag.)

Moreover, MaaS opens up opportunities for Transport Providers to take transport services to the next level by becoming a part of people´s everyday. By beeing part of an innovative ecosystem, transport providers can concentrate on core competencies instead of fare management, advertising and customer service. (Eltis 2016, n.pag.) In addition, a change of travel behaviors offers access to new passenger markets, and further a revenue growth opportunity from previously unreachable customer markets (Datson et.al. 2016, S.17)

Summary of the Benefits of Mobility as a Service for Users, the Public Sector and Economies:

Benefits for Users:

- Easy access to integrated mobility solutions
- Seamless Door-to-Door Mobility, with a better level of service than private cars
- Reduction of the need to own a (second) car
- More Affordable Mobility and cost savings for users
- Improved flexibility and convenience of public transport
- Incentives for more sustainable travelling habits
- Encouragement of a more active and healthier living
- Higher availability of mobility alternatives
- Improved Accessibility by creating solutions for the first and last mile
- Better access to Opportunities (e.g. employment, education, health and leisure)
- Better access to Mobility: reduction of isolated areas and districts

Benefits for Cities / the Public Sector:

- Support of Political commitments and a more effective achievement of policy goals
- Improvement of policy decisions by the use of data and information
- Saving of Public Money through a more efficient allocation of Resources
- Increase of the efficiency and attractiveness of public transport

- Mitigation of peak-traffic issues
- Reduction of car-ownership and traffic volume
- Reduction of traffic congestion and disruptions
- Reduction of GHG-emissions and pollution (CO2, particulates, Noise)
- Generation of new opportunities for a greener and more livable transformation of cities

MaaS creates Businesses Opportunities

- Access to jobs, services and markets
- Generation of new market and business opportunities, offering additional revenues and market growth
- Improvement of business activity and asset management (e.g. scheduling, routing, staffing)
- New potentials for transport operators to increase both customer base and creation of value

5.1.4 Differences on Geographical Areas

It can be seen that be MaaS could have an important impact on city planning in both urban and rural areas. It is probable that the evolution and deployment of MaaS can increase the attractiveness of different areas by improving life quality and the well being in general. However, it has to be mentionned that these impacts may be different depending on the geographical area where MaaS is supposed to be implemented. (König et.al. 2016, p.43ff)

In Urban Areas, the Main objective of MaaS will be to tackle congestion and environmental issues (pollution, noise, air quality) as well as parking problems. Further, a decrease of ownership and use of private cars and to improvement of the efficiency and quality the of transport networks and operations has to be pursued. Practically, the only way to reach the objective or even make private cars unnecessary in cities is to include all the available transport modes in the service coverage. At least car sharing, bike sharing, buses, taxis, ferries, trams, subway and local / commuter trains must be available – or are going to be available shortly – in most of the big cities in the world. (König et.al. 2016, p.55)

In contrast, the MaaS outcomes in suburban and rural areas differ to the expected impacts in urban Areas. Since the availability of public transport can be limited to some extent, people may have a more permanent need for more than one personal car.

In **suburban Areas**, MaaS is expected to improve service levels (i.e. trams, buses, subways) by integrating taxis and other demand-responsive transport and mobility services with public transport. In addition, these areas are potential locations for car-pooling and ride-sharing if effective tools and platforms for managing those are available. By proving extensive park and

ride facilities, at least emissions and problems caused by private cars in urban and suburban areas can be diminished. Therefore, the elimination of private cars will be less plausible, even though the need for owning a second car may probably be reduced. (König et.al. 2016, p.55f)

In sparsely populated **Rural areas** are more often suffering from a lack of connections to long-haul and scheduled services, often lacking First- and Last Mile Connections. Therefore, MaaS-enabled demand-responsive transport services might provide significant benefits, as the current service level could at least be sustained for a low number of users, the utilization rates increased and thus the efficiency improved.

Furthermore, Accessibility is important for both for inhabitants and tourists in rural areas. Hence, the socially and publicly supported transportation (including school and statutory social service transportation) is another issue, that could be made more efficient and cost-effective (including cost effective) through MaaS. Because taxis handle most of these rides, generally it is about increasing efficiency rates by combining rides instead of driving individual customers as now it usually done. In Addition, embedding services, e.g. library services or small patch deliveries (medicine and food), as part of the MaaS packages, could be provided and again the efficiency could be increased. (König et.al. 2016, p.56f)

5.2 Goals of Mobility as a Service

It can be stated that MaaS does not only benefit users and cities, but also is creating an innovative ecosystem that offers a broad potential of new market and business opportunities. The next logical step is to integrate the view of transport and mobility within a much wider perspective. As already mentioned in chapter 6.1.2, MaaS is expected having *the potential to be an effective instrument to **support** the achievement of public or transport **policy goals**. It has been stated that MaaS is offering the potential to support political commitments through the more effective achievement of transport policy goals.*

Based on the literature review, goals and objectives of the MaaS-concept aren´t explicitly mentioned to be part of transport policies. Therefore, the various benefits that are expected to arise through the deployment of Mobility as a Service are used to derive goals and objectives that could be probably set by transport policy. It is assumed that the "outputs" deliver appropriate solutions to mobility challenges, and that the benefits further are consistent with the objectives that are going to be linked to the MaaS-Concept. In addition, if the concept of Mobility as a Service can potentially help to bring about beneficial behavior changes, then it can also potentially support wider social, economic and environmental issues. (Burrows et.al. 2015, p.23) Basically, it can be expected that there will be a certain connection between different objectives, since the achievement of possible goals of transport policy can potentially impact, if stipulated in a right way, e.g. wider social or environmental issues as well.

Transport Policy

- Improve Efficiency of allocation of Resources
- Reduction of car ownership
- Reduction of traffic volume and (urban) congestion
- Increase the attractiveness of public transport, walking and cycling
- Improve the Level of Service of public transport
- Increase the Efficiency of Use of Transport Capacities

Environment

- Reduction of environmental impacts of vehicles
- Encouragement of more sustainable mobility behavior

Society

- More affordable mobility for citizens: Provide cost-savings for the customers
- Improve Accessibility and Reachability of Districts and (Rural) Areas

Economics

- Generation of Jobs and Economic Growth
- Making places more attractive to live, work and invest in

5.3 Political Commitment of MaaS

Besides the main components that have already been identified as integrated parts of MaaS (Chapter 5), setting up the regulatory framework providing strong governance structures are considered at least as important in order to pave the way towards a consistent MaaS. (König et.al. 2016, p.12f) In order to realize the full potential of the concept to provide sustainable impacts, it is important to perform other forms of integration from different institutional perspectives, such as public and transport policy. There is need for pro-active policy of each governmental level; policy should avoid being reactive and only respond to the conflicts as they arise. It should rather anticipate the upcoming development and develop a forward looking vision. (Finger et.al. 2015, p.10)

Public authorities are vital in the transition from the present system to a service ecosystem in mobility. Through smart regulation, the public sector should act as an enabler imposing the frame conditions, including the modification of the regulatory framework, support programs for standardization, as well as target-oriented planning instruments. (VDV 2013, S.10) The VDV suggest these actions to be taken over by cities, municipalities, federal governments, and the EU in the form of common objectives and concrete measures. (Heikkilä 2014, S.67)

These need to be complemented by Pilots and test areas, in order to develop practical knowledge and experience for future development processes. Testing operations (e.g., a new service) first in a minor scale indicates the need for improvement but requires merely a small

budget. This practical knowledge can be used to develop projects and concepts and then introduce them again to the market. (Heikkilä 2014, S.67 & S.76 & Hietanen 2014, S.3)

In order to be able to better define the scope of political decisions on the transport sector and mobility options of the future, a clear political commitment of the transport policy is required, in addition to innovative thinking approaches and pilot projects. In many areas there is a clear lack of a revision of these transport policy strategies as well as the legal framework, which is still too much oriented on the interests of some stakeholders. (Flügge et al., 2016, p.228)

Without specific objectives of transport policy linked to Mobility as a Service, it can be assumed that only a small target group will actually be reached, which are usually the users of the first hour (Early Adopters). Only through clear political goal, it will be possible to motivate political decision-makers and economic interested groups to implement MaaS and to strengthen the willingness to cooperate. (Flügge et al., 2016, p.228) Therefore, it will be important to anchor MaaS directly and purposefully as a political objective in strategic programs and to prepare suitable transport policy strategies. By means of an adequate transport policy, it would be possible to make use of mobility opportunities beyond purely economic interests and effects. (Russ, Tausz 2015, n.pag.)

Holmberg et.al. (2015, S.45) refer to many experts that argued, for the integration of transport policy and urban planning and development practices. Currently, there is a fragmentation between different policies that influence the transport sector (e.g. transport policy, environmental or economic policies, as well as urban planning). Therefore, is seems to be important to “strengthen the links between land use and transport”. In order to encourage and motivate people to adapt more sustainable transport modes as well as walking and cycling, it is useful to integrate new trends within sustainable urban planning (e.g. compact and mix-used cities, clustering around public transport hubs, Transit Oriented Development) must be integrated with local factors linked to parking fees, congestion charging, city-center accessibility, public transport subsidies, and bus/cycle lanes as part of a shift towards a more sustainable road transport system.

These factors are very specific for the promotion of MaaS. That is, urban planning and development activities are fundamental in that local governments can establish institutional arrangements (e.g. increased parking fees, reduced congestion charges, bus lane provision for MaaS vehicles, etc.) that can promote the implementation and adoption of sustainable forms of MaaS. (Holmberg et.al. S.45f)

5.4 Indicators

Goals of conceptions and new approaches as well as future developments can always only be forecast within certain limits. Therefore tendencies in the development of traffic and the mobility behavior of the population have to be monitored regularly. At the same time, progress in implementation and the achievement of objectives and strategies need to be

identified as well. (Vienna City Administration 2014, S.24) For this purpose, an ever increasing amount of data can be used to analyze and to observe the development of mobility and traffic in cities and rural areas. Hence the same applies for the implementation of Mobility as a Service and the potential objectives of the concept.

The chosen indicators are important reference values to examine the effectiveness of measures and identify areas where steps need to be taken. They are useful for city´s policy to monitor the effects and impacts of measures, allows to monitor major trends and developments and thus the setting and revising of objectives. Thus policy activities, decisions and the implementation of measures can be justified and the results of cities mobility policies and activities be communicated. (Stantchev et.al. 2016, n.pag.)

The selection of appropriate Indicators for the defined objectives was conducted through the consultation of i.e. the existing urban mobility plans of the cities of Stockholm and Vienna. However, the most important part of the indicators is adopted from the approach of the World Business Council for Sustainable Development (2015, S.4ff), delivering a set of indicators as a tool for cities to perform a standardized evaluation of their current situations of the mobility system and to evaluate the potential impacts of new mobility practices or policies. If repeated over time this exercise will reveal the measures impacting the most efficiently on specific indicators and thus allow other cities to select the best measures in the context of a targeted action. (World Business Council for Sustainable Development 2015, S.6)

Transport and Public Policy

Objective: Improve the Efficiency of the Allocation of Resources

Indicator	Definition	Source
Net Public Finance	Net results of government and other public authorities revenues and expenditures related to transport sector	1)*

Objective: Reduction of traffic volume and (urban) congestion

Indicator	Definition	Source
Motorized Traffic densities, during peak-hours and off-peak	Mean weighted traffic densities (number of vehicles) during peak and off-peak	2)*
Commuting Time	Average Duration of commute to and from work or an educational establishment (in minutes per person per day)	1)*

Objective: Increase the attractiveness of public transport, walking and cycling

Indicator	Definition	Source
Modal Split in Passenger Transport	Percentage of travelers using public transport	1)*

Average distance covered by car	Average distance of people covered by (private) car (km)	2)*
Average distance covered by eco-friendly transport modes (PT, Bike, Foot)	Average distance of people covered by eco-friendly Transport Modes (km)	2)*
Availability of intermodal connections	Number and frequency of the connections between the different transport modes.	1)*
Transport Demand	Number of Passenger on Public Transport (per year)	2)*
Opportunities for Active Mobility	Length of roads and streets with sidewalks and bike lanes or 30 km/h zones and pedestrian zones, in relation to the total length of city road network.	1)*
Physical and Mental Comfort and Pleasure of Citizens while using public transport services	Average reported satisfaction about comfort of city transport and of pleasure of moving in the city area.	1)*
Satisfaction with Mobility Options	Satisfaction with Public Transport	2)*
	Satisfaction with pavements and footways for pedestrians	2)*
	Satisfaction with cycling path network	2)*
Use of alternative Mobility offers	Number of Registrations / Subscriptions to other mobility services	1)*

Objective: Reduction of car ownership

Indicator	Definition	Source
Motorization Rate	Number of (private) cars per 1000 inhabitants	1)*

Objective: Improve the Level of Service of public transport

Indicator	Definition	Source
Share of Public Transport of motorized transport during peak-hours	Share of the journeys by Public Transport in relation to car-related trips	3)*
Transport Capacity during peak-hours	Transport Capacity (Passenger / hour)	3)*
Public Transport Service	Operating Performance of Public Transport; Total Capacity (places incl. Seats and standees), in mill. Km	2)*
Public Transport Reliability	Percentage of Seat and Standee place km which Public Transport Operator failed to operate	2)*
Average Travel Speed of Public Transport	Average travel speed of tram or bus, during peak / rush hours and during off-peak / evening hours	2)*

Objective: Increase the Efficiency of Use of Transport Capacities

Indicator	Definition	Source
Occupancy Rate	Average load factor of vehicles, often defined by mode (cars, public transport, …)	1)*

Environment

Objective: Reduction of environmental impacts of vehicles

Indicator	Definition	Source
Emissions of Greenhouse gas	Total of air poluting emissions of all transport modes (tonne CO2) per year, per capita.	1)*
Traffic Noise Hindrance	Percentage of Population hindered by noise generated by traffic in close surrounding of homes	1)*
Energy Efficency	Total energy consumed by transport sector (total energy used per passenger km) per year (annual average over all modes)	1)*

Objective: Encouragement of more sustainable mobility behavior

Indicator	Definition	Source
Active Mobility	Share of Bike and Walking	2)*
Car-Use	Percentage of the population using a car several times a week	2)*
Bike Ownership	Number of people owning a bike	2)*
Modal-Split of Passenger Transport	Modal Split for the population, referring to the number of trips	2)*
Multimodality	Number of people using at least 2 modes of transport within a week	2)*
Intermodality	Number of people using at least 2 modes of transport within a trip	2)*

Society

Objective: More affordable mobility for citizens: Provide cost-savings for the customers

Indicator	Definition	Source
Affordability of public transport for the poorest group	Affordability of the public transport cost for fulfilling basic activities of the household budget for the poorest quartile of the population	1)*
Average Expenditures of Citizens for (individual) mobility consumption	Average Transport Costs spent by a mobility user per year	

Objective: Improve Accessibility and Reachability of Districts and (Rural) Areas

Indicator	Definition	Source
Reachability of POIs	Percentage of People with access to opportunities / occasions located within a certain distance from their home (e.g. 1500km)	2)*
Accessibility for (deficiency) groups to transport and	Average reported convenience of city transport for target groups)	1)*

mobility services		
Access to mobility services	Percentage of population with appropriate access to Public Transport (Stop or Station)	1)*
	Percentage of population with appropriate access to Car-Sharing	2)*
	Percentage of population with appropriate access to Bike-Sharing	2)*
	Percentage of population with appropriate access to other Mobility Services	

Economics

Objective: Generation of Jobs and Economic Growth

Indicator	Definition	Source
Degree of Accessibility to Job Market and Education System	Citizen´s perception of potential difficulties in accessing the job markets and / or education systems due to mobility network	1)*

Objective: Making places more attractive to live, work and invest in

Indicator	Definition	Source
Quality of Transport Network, perceived by business owners and citizens	Percentage of business owners who consider that the cities transport network satisfies their needs	3)*
	Percentage of people who consider transport network satisfies their needs	3)*
Share of Spaces for cycling, walking and public transport	Sum-Total of Spaces for cycling, walking and public transport	2)*
Share of Spaces for Parking Areas	Sum-Total of Spaces for Parking Areas	
Mobility Space Use	Proportion of land use, taken by all city transport modes, including direct and indirect mobility space usage (m^2)	1)*
Fatalities by road and rail transport accidents	Number of casualties per year, caused by urban transport	1)*
Quality of Public Area - Presence of attractive areas such as pedestrian street or squares which facilitate social activities and encourage citizen´s interaction	Reported Usage of streetsand squares and subjective appreciation of the public area quality	1)*

***Sources:**

1) World Business Council for Sustainable Development 2015, S.35ff
2) Vienna City Administration 2012, S.24ff
3) City of Stockholm Traffic Administration 2012, S.22ff
4) Smile Mobility 2015-2, n.pag.

6. MAAS CASE STUDIES – MOBILITY SERVICE INITIATIVES AROUND THE WORLD

Cities, Policy Makers and even external players have recognized the need to create a new mobility approaches, setting up a network of public and shared modes that provide integrated mobility services that are viable substitutes to private vehicles.

The following case studies of MaaS-Concepts provide on a selection of different pilots and projects aiming to develop various approaches of integrated mobility, varying in the level of integration of the service features, including different transport modes and applied to different geographical areas. In this context, there will be a selection of integrated mobility services respective MaaS-Concepts has based on the definitions that are described in Chapter 3.2. These cases are described using the core elements of MaaS illustrated in Chapter 5. After that, there should be an evaluation of how cities have developed after the implementation of Mobility as a Service, using the indicators that have been chosen to describe the policy related goals and objectives indicated in chapter 6.

6.1 MaaS-Concepts

6.1.1 Whim, MaaS Global (Finland)

MaaS Global is the world's first mobility operator as a service company, also known as the Helsinki Model, supposed to be the first implementation of a fully integrated Mobility as a Service. Currently in a pilot stage, it is expected to be completely applied by 2025. MaaS Global is aiming to stimulate the development of full-scale MaaS solutions. Launched as MaaS Finland, the company was later named MaaS Global to reflect the vision for global expansion (e.g. United Kingdom, Canada, Australia). (MaaS Global n.d.-1, n.pag.)

A group of eight investors lead by Transdev (Veolia) have teamed up forming a MaaS operator. The project brings together 23 partners including a variety of research organisations, ITC and transport companies, besides the transport operators. It aims at an open market model based on brand cooperation. Inter alia, Maas Global has already established agreements with Finland's rail and city public transport companies. (MaaS Global n.d.-1, n.pag.)

The Whim-Application will be a one-stop urban mobility solution, offering its users multimodal and mixed modal trip suggestions. Whim offers both monthly mobility packages that bundle monthly travel requirements at a single price as well as travel on a 'pay as you go' basis. Yet, Monthly packages, however, include better benefits.

Offering an all-inclusive multimodal transport app, ICT, ticketing and payment integration are at the heart of the project. Users open Whim, enter their destination, and pick from a number of potential options and routes, including buses, trains, taxis, bikes, and even cars to offer to take people door to door as easily as possible. The application synchronizes with the user's calendar, helping to plan journeys in advance and allowing people to plan their route in

advance and buy their tickets. Whim also learns about the user's preferences. In Addition, Whim always encourages the use of public transport. In the future, it will even reward you for travelling greener. (MaaS Global n.d.-2, n.pag.)

Currently, the system connects all Finnish cities and public transport networks (Helsinki Transport Authority HSL/HRT). Furthermore, agreements with the car-rental company Sixt and with Taxi Services can be purchased via the Application. In the future, MaaS Global is looking at integrating services like Uber and Lyft.

Even tough the project is not yet operational, it is projected to provide pre-purchasable and pre-constructed mobility packages. Each package will be tailored towards a specific socio-demographic group such as families, commuters or businesses. (MaaS Global n.d.-2, n.pag.)

Currently, there are **three mobile service options** available to consumers: one that combines several modes of transportation for a single trip (Light); one that combines private car use with an extensive range of public transport services (Medium); and one that offers a comprehensive service for all transportation needs at a monthly rate (Premium). (MaaS Global n.d.-2, n.pag.)

Figure 17: Whim Mobility Packages

(Source: MaaS Global n.d.-2)

The user has the possibility to automatically refresh his packages each month. However, the user is allowed to change, upgrade or even cancel his subscription before the start the next subscription period.

A further element is ***Whim Car***, a brand new car concept, which offers rental cars at a super affordable fixed day rate (24 hours). It's by far the cheapest alternative for one-day rentals, but you also have the option to rent your Whim Car for a longer period. With 4 price categories to choose from, there is sure to be a car that suits your needs. Whim Car differs from traditional car rental with its always guaranteed fixed price. This new car concept is only available with your Whim subscription. (MaaS Global n.d.-2, n.pag.)

Another interesting project is that besides the modes included in the above-mentioned projects, MaaS Global also plans on-demand transport services. A similar project, the on-

demand minibus service Kutsuplus ("Call plus") – a fleet of nine-seater minibuses - was already operated by the Helsinki Regional Transport Agency for 4 years, and one of the most innovative component of Helsinki´s and Finland´s intelligent traffic system. (Moss 2015, n.pag. & Fountain 2016, n.pag.)

The routes of the buses are determined by the bookings they get on any given day, responding to the real-time needs of customers. Using a smartphone, customers could choose pickup and drop-off locations. The service's software combined requests from several customers and calculated an optimal route for its minibuses. The problem was that, so far, Helsinki only has 15 buses, and doesn't have the funding for any more. ***Kutsuplus*** was heavily subsidized by the city, and although the service was popular and gaining riders, it was doomed by budget cuts. (Moss 2015, n.pag. & Fountain 2016, n.pag.)

6.1.2 Tuup, Finland

Tuup, a Helsinki-based mobility start-up, is developing a multimodal mobility application, which integrates various mobility services as well easy and secure ticketing and payment in one application. The Turku Region Traffic, also known as Föli, is the first mobility service to offer purchasing via Tuup. In 2015, the existing mobile ticket solution for Turku's public transportation was chosen the best mobile service in Finland. Now the mobile ticket will be extended to a mobile ticket solution. (Tuup 2017-1, n.pag.)

Tuup offers an Ecosystem of various mobility service providers. The Collaboration network includes Finland's national railway operator VR, Helsinki Region Transport, Turku Region Traffic, the Finnish Taxi Owners' Federation, as well as companies providing parking solutions and shared bicycle use. Once having established a wide MaaS-Ecosystem in Finland, Tuup even aims to introduce services applicable for the global market. (Tuup 2017-1, n.pag.)

Tuup offers ICT integration through an intelligent application that offers a journey planner (schedules, routes and fares), and allows an easy and quick finding, comparing, booking and paying for the use of various mobility options, ensuring a seamless user experience.

The intermodal journey planner generates an optimal transportation plan for the user by combining the most suitable modes of public and private transportation, according to the users preferences. It is easy to compare different route options, based on speed, price or emission rates of different transport options. Tuup even integrates the real-time departures of public transportation in the biggest Finnish cities. What is more, it is possible to hail a taxi or ride-sharing opportunity, and search for search for rental car pick-up points or available cars. Further, integrated payment enables the user to pay for their Föli ticket for the public transportation in Turku within the app. Ticket options will first include adults' and childrens' single tickets as well as the 24 hour day tickets and later be extended to other options.

Tuup is an Agenda based travel planner, optimized for daily agenda on personal preferences (time, price, exercise or emissions – and mobility history). The app can synchronize with the

user's calendar providing them with an optimal plan for the day's travel needs, telling when to leave and revising the plan if there are traffic disruptions. Parking is also included in the solution. The Application learns from the preferences by the choices user make and assists them by giving Reminders and by figuring out new alternatives and option, when things don't go according to plan.

Tuup offers a multimodal traveling, including various mobility options into one single solution: Public Transport, Intercity Bus & Train, Car-Rental & -Sharing and City-Bikes, and considers even using the own car. In the future, Tuup aims to expand its service and include other public transportation services, e.g. car and bicycle rental services and parking services, as well as Long-Distance busses and trains and partnerships with Taxi Services (e.g.the Finnish Taxi Owners Federation and the taxi center of southwest Finland, LSTD Oy). Additionaly, Tuup aims to include the trade-carpooling service PiggyBaggy.

Furthermore, the taxi-pooling service Kyyti (Finnish: Ride) will be integrated in the Tuup application. The service will be first launched in Oulu 2017, and later be extended. Kyyti offers on-demand door-to-door-rides, based on the idea of sharing a taxi with other customers. Therefore, the service is considered to be a missing element in the mobility market, since it provides a solution for the first / last mile problem. (Tuup 2017-3, n.pag.)

The Kyyti system is based on the efficient use of vehicles, enhanced by a fully automated process from customer's order to ride matching and fleet management. The service offers to all customers an affordable pricing based on affordable pricing is based on aggressive dynamic pricing, shared capacity and the optimized use of the fleet. Great value prices are available for all passengers when everybody is willing to share the ride with others. (Tuup 2017-3, n.pag.)

Price for all service categories is always paid in advance and will be final. Customer can choose from three service categories and have lower price by being flexible in waiting or travel time. Service categories are the "taxi-like" Express option, the slightly more flexible Flex option, or the cheapest Smart option, if your travel needs don't require you to be on a tight schedule. The customer can significantly affect the price by giving us more possibilities for pooling flexible Kyyti if you are able to be flexible in your travel and waiting times. (Tuup 2017-3, n.pag.)

Another special project is the planned launch of a demand responsive robot bus service in Finland during 2017, which will be conducted by Tuup in cooperation with Vinka and Sohjoa project. The purpose of the automated bus project is to attract Finnish companies to take that first step towards automation and to build permanent development activities and businesses in the field. (Tuup 2017-2, n.pag.)

Tuup will provide the service to the public through its travel planning application available already now in several parts of Finland. Vinka will develop the automatic demand responsive ride sharing and fleet management intelligence, while Sohjoa will provide the piloting platform. (Tuup 2017-2, n.pag.)

6.1.3 UbiGo, Sweden

UbiGo is project offering a multimodal urban mobility platform, piloted in the city of Gothenburg in Sweden in 2014. The project was part of the Vinnova-funded Project Go:Smart, with partners such as Volvo, Chalmers university, City of Gothenburg, the Swedish Viktoria Institute, Västtrafik and the Lindholmen Science Park. It is one of the most ambitious and promising efforts to create a fully integrated service for the much discussed Combined mobility and Mobility as a Service. (UbiGo 2013)

The UbiGo service was tried in a real living lab by forming an fictive company, showing the viability of the business model, with paying customers under real commercial conditions. During 6 months, 70 urban households subscribed to a fully-integrated mobility service, allowing them to use car sharing, car rental, taxi-services, public transport or bike-sharing for a monthly subscription fee. Everything was easily accessible using one app. (UbiGo 2013)

The project involves the cooperation between Vasttrafik public transport operator, Sunfleet Car-Sharing, Hertz Car-Rental, TaxiKurir taxi service and JCDecaux bike-sharing. The ICT, payment and ticketing integrated service combines everything into one application – even bike-sharing or car-rental can be managed and accessed with the application. (UbiGo 2013)

The main service interface was a mobile phone applxication that provided users access to the offered services. To access their transport services, Ubi.Go Customers logged into the interface via a Google- or a Facebook-Login. In the app, they could activate manage their bookings, activate purchased tickets/trips, and access already activated tickets (e.g. for validation purposes). The app also allows to check their balance, bonus, and trip history, and get support. However, it has to be noted that pre-or on-trip journey planning or real-time-public-transport- information has not yet been included. (UbiGo 2013) In Addition, each participant received a smartcard, used for access to bike-sharing or to unlock a booked car, but also charged with extra credit for the public transport system in case there was any problem using the UbiGo service. (König et.al. S.36f)

Households subscribe for tailored monthly packages determined in time or distance for each mode separately. For example, public transport is determined as days in one or more zones, car-sharing, car-rental as days an taxi as distance. The subscription is based on prepaid credits, and users were free to choose their subscription level starting from a minimum of 135€ per month. Credit could be topped up or rolled over depending on how much credit the household utilized, and the subscription could be modified on a monthly basis. (König et.al. S.36f) If the cards run empty, extra days or hours will be registered and billed afterwards, as will taxi-trips, waivers etc.

The household creates their packages based on their needs as a household as a whole, and the price of the package is cheaper than the same amount of service would be on its own. During each journey planning, the user makes their own travel decision on transport modes based on their monthly packages. If the subscription runs empty, additional trips will be registered and billed after. Un-used days or hours will be saved for later use. (UbiGo 2013)

Further services include the availability of electric cars and bikes as well as a bonus scheme for sustainable choices. For every kilo CO2 saved (compared to if the trip would have been made by private car), users get bonus points that can be used to purchase services or products from UbiGo partner organisations (bike service, home delivery, health clubs, concerts etc. Furthermore, if there are longer delays in the public transport, the customers will get a taxi without any paperwork afterwards. (UbiGo 2013)

The Results from the evaluation executed after the pilots, based on surveys, interviews, travel diaries, focus groups and usage were very positive. In fact, it has been concluded that the project has been proven in reality. During the pilot, over 12 000 transactions (day - tickets, car or taxi-reservations etc.) where made and that no single household stopped using the UbiGo subscription, and that most of them wanted to continue to use the service. The main reason for taking part has shifted from curiosity to convenience, which is exactly what hoped for. Also, the economy grew in importance. (UbiGo 2013, n.pag.)

Half of the users changed their modes of travel, four out of ten have changed the way they plan their trips and one out of four have changed their “travel-chains”. They say that it has become easier to pay for the travel, they have better control of expenditures, they have gotten access to more modes of travel. (UbiGo 2013, n.pag.) Actually, six months were enough for most of them to change behavior and continue with their new behavior. (Flügge 2016, S.212 & S.216)

After the end of the very successful pilot in Gothenburg, a project a group of individuals from the project started Ubi.Go Innovations, with the purpose of refining the concept and introducing it on a larger scale. In cooperation with Ericsson AB and the ICT Viktoria Institute, a relaunch of Ubi-Go is planned for Sweden in 2017. (Rise ICT HQ 2017)

6.1.4 Smile, Vienna (Austria)

The aim of the Smile Project (Smart Mobility Info & Ticketing System) …is an ambitious project trying to grow into a working prototype of intermodal integrated solution by delivering multimodal options, information, booking and payment trough a smart and efficient system. (Smile Mobility 2015-1)

The smile project provides a break-through in terms of usability and as an enabler for integrated multimodal mobility services. The integration of multiple mobility providers throughout Austria such as ÖBB (Austrian Railways), Wiener Linien (Public Transport Vienna), Taxi 31300 (Taxi Service), Car2Go (free-floating car-sharing), Emil and Emorail (e-carsharing), Citybike (bike sharing), Tanke (Charging network for eCars) and many other services is a unique achievement. (UITP 2015, S.19)

Smile aims to offer a mobility platform that integrates various means of transport (public transport, rail, car-sharing, bike-sharing, car-rental, taxi) and combines them with routing information and user data to provide individual mobility offers. ICT integration is povided via the SMILE App, which is the user interface of the mobility platform. With the application

interface, all functionalities of the mobility platform are easily accessible: Information – Booking – Payment – Usage – Billing.

The user is informed about available means of transport **in the area** around the current user location by an interactive map. Further information can also be accessed, e.g. departure times of public transport, available rental bikes, conditions of a car-sharing vehicle or the available charging points in park houses. For trips, the platform offers different individual options and combinations. These can be sorted by mean of transport, time, price or CO2. With a filter certain means of transport can be filtered individually. What is special is the tinformation of CO2-emission for each mode and route, which is an important move towards sustainable transport as it provides the user with the necessary information to make green travel choices. (Smile Mobility 2015-1)

The smile app shows the total price for the entire trip as well as for each segment. The app considers season tickets, discounts and memberships (e.g. from sharing providers) as well as private vehicles which can be saved in the mobility profile.

The whole trip can be booked, reserved and necessary tickets bought from the providers directly via the app. The secure, cash-free payment process runs completely in the background. After the payment was authorized the tickets will be directly shown within the smile app. Payment integration is also linked to the application. For services that depend on usage (taxi, car-rental, car-sharing, bike, parking etc.) the customer is charged right after usage, after the final price has been calculated. At the end of a ride a push notification appears on the users' mobile phone confirming the final price. By tapping it the price is accepted and the ride is paid for. (Smile Mobility 2015-1)

According to the specific user request the data will be selected and combined to provide the most suitable options for the requested trip (including the actual price). Additionally the users then had the chance to choose an option to book the entire trip – even with several mobility providers – without changing between different apps. (Smile Mobility 2015-1)

The platform was tested for over a year. More than 1000 external persons registered for the pilot operation. Afterwards the changes in mobility behavior were surveyed. The results of the scientific evaluation showed that the usage of smile led to a more environmentally friendly mobility behavior, and thus is the key to a multimodal and intermodal traffic system that will encourage the spread of e-mobility and incentivize public transport. (Smile Mobility 2015-2 & UITP 2015, S.19)

More than 1,000 external persons registered for the pilot operation and extensively tested the platform and its functions. In three phases the user-base was continuously expanded. Every person subscribed used Smile as much as possible to provide feedback and to improve the service in regular iterations. Later, an external pilot operation started, and Smile was tested by the users under regular circumstances. Afterwards, the evaluation of the pilot operation of Smile has been conducted, in which roughly 17% of the pilot users took part. The most

important results that has been achieved is that the implementation of Smile increased the usage of sharing offers and e-mobility and reduced the usage of private cars.

It has been stated that Smile increased the intermodality of pilot users, since customers confirmed an increased use of public transport in combination with their private cars, as well as shared- or private bikes. As the main motivation for the increase in combinations of public transportation and car / bike was specified the quicker alternatives Smile suggested.

Further, the usage of the mobility platform led to changes in the choice of the transportation modes chosen by the pilot users. It increased the usage of public transportation, sharing offers and e-mobility and at the same time reduced the occasions when private cars were used.

Just as well, the use of the mobility platform supports breaking the mobility routines and increased usage of alternatives by the pilot users. Over two thirds of the respondents tried new alternative routes suggested by Smile, and chose to use more efficient, attractive or environmental friendly routes. (Smile Mobility 2015-2, n.pag.)

6.1.5 Hannovermobil, Hannover (Germany)

Introduced for the first time as Hannovermobil, and failed on its high expectations, a modified system has been relaunched in 2016 as Hannovermobil 2.0. This second phase of üstra´s (Hannover´s public transport operator) and GVH´s (Greater Hanover Transport Association) "Mobility Shop" is considered to be the very first fully operational example of a MaaS. (Röhrleef 2014, n.pag.) The idea behind Hannovermobils "*Mobility Shop*" is to combine Public Transport information and ticketing, taxi services, sharing concepts and other information (e.g. Points of Interests) over a common mobility platform, handling just a single membership. The geographic service covers the urban and surrounding region of Hannover. (König S.21f)

The Mobility Shop is a truly multimodal version. ICT integration is being developed based on the Hannovermobil pilot scheme that will include a smartphone app with real-time information. The core feature of the service is an integrated workflow integration of registration, routing, booking and invoicing for several transport modes (public transport, taxis, station-based and free-floating car-sharing), covering different mobility options for the needs of various target groups. (üstra Hannoversche Verkehrsbetriebe AG 2017 & UCL London Institute 2015, S.16)

More flexible than the original pilot, the service is not exclusively limited to the holders of annual season passes of public transport anymore, thus offering itself towards a much broader share of the 'multimodal' target group. At a monthly fee of €9.95, Mobility Shop offers multimodal mobility provided by Public Transport Operators üstra and GVH in cooperation with Stadtmobil, Hallo Taxi 3811 and Deutsche Bahn. (üstra Hannoversche Verkehrsbetriebe AG 2017)

The service offers users the possibility to tailor the bundle to their individual needs and to directly book their journeys, whether getting a ticket for public transportation, book one of

Stadtmobil's shared-cars or order a taxi-service - including travel times, appearing in real time and all cashless and location-independent. Being a customer of Mobility Shop means being a customer of Stadtmobil carsharing and Hallo Taxi 3811 as well, without having to pay the usual admission fee. In addition, customers are granted heavily discounted rates for Stadtmobil car-sharing as well as for Hertz Car-Rental and taxi services. Moreover, a free discount card (BahnCard 25) is included for the long-distance rail operator Deutsche Bahn. (Mobility Services 2017, n.pag. & üstra Hannoversche Verkehrsbetriebe AG 2017)

Having these different types of urban mobility combined in a single service, users get tickets quickly and easily, have a transparent cost overview and can use the different means of transportation according to their individual preferences. Further, one single card can be used to access public transport and sharing-vehicles, providing ticketing integration between Üstra, the public transport provider, and Stadtmobil car-sharing. (Mobility Services 2017, n.pag.)

For all services used, customers receive an integrated "joint mobility bill" at the end of each month that includes all basic cost as well as taxi and car-sharing usage fees. Yet, this advanced integration is only available for public transport, car-sharing and taxi-services. Long distance rail and Hertz car-rental prices are not included in the mobility bill, which is why the integration is only basic between these parties. (UCL London Institute 2015, S.16)

Since the establishment, an increasing number of registered users and the growing volume of sales showed the economic success and the user acceptance, and thus making the project a good example a sustainable integrated mobility solution. Mobility Shop is identified to contribute to the decreases of the need of owning a car, offering extensive and multimodal mobility and fostering the choice of environmentally friendly means of transportation. Mobility Shop provides simplified, transparent and individual mobility for the inhabitants of Hannover. (Mobility Services 2017, n.pag.)

6.2 MaaS-related Concepts

6.2.1 Moovel

With the Moovel application, the Moovel Group, a subsidiary of the automotive manufacturer Daimler, offers a "mobility app", which offers full integration of different means of transport as a complete "one-stop shop" for urban mobility. Moovel integrates countrywide mobility in Germany via a single smartphone platform. It includes public transport, car-sharing, car-rental, national rail, bike-sharing and taxi, all provided by separate operators such as Car2Go, MyTaxi, NextBike, and DeutscheBahn. In the future it is planned to offer the offer not only in Germany, but also in many other countries, by integrating further mobility partners. (Moovel Group 2017-1)

In all of Germany, public transport tickets can be booked and paid directly to the transport companies of Stuttgart and Hamburg, Deutsche Bahn, the car2go and Flinkster car-sharing providers, taxi operators mytaxi and taxi call, as well as extensive rental bicycle offers (including Nextbike, Norisbike or MetropolradRuhr.). Car-Sharing such as Car2Go is seen as

the key to achieving a much wider deployment of the Moovel service. Car2Go was the first car sharing system in the world without fixed rental locations, which ensures sufficient flexibility to meet demand. (Moovel Group 2017-1)

The core of the service is an extended ICT integration. The Moovel mobile application offers and easy intermodal journey as well as planning, booking and (yet still restricted) payment options. The app shows available options and compares mobility services from various providers in terms of ticket price and duration, to find the optimum route from A to B. Using an interactive map view shows all nearby transportation options or trips for the desired destination. The users can compare all the available routes and transportation, using all the information about the trip in detail, such as route, distance, journey time or costs, and select the trip chain that fits best their needs. (Moovel Group 2017-1)

The route planner contains an integrated payment function for all services, except for NextBike and, still Car2Go. Moovel allows the users to book the ticket, the ride or the rented car and / or confirm the payment directly to the personalized Moovel account. There is no need for cash – it can easily be paid for the chosen mobility options directly through the interface. Moreover, Car-Sharing or Taxi-Services can be located and selected directly within the interactive map, and paid easily and directly. The details of the booking will be displayed on the interface, sending a push-notification when the driver has arrived. The service can be paid at the end of the trip journey; it is even possible to tip the driver in the app. (Moovel Group 2017-1)

In Addition, discounts such as *BahnCards* or a *bahn.bonus-Cards* can be entered and considered in the booking and payment. Tickets and Reservations are saved in the application and can be found in a digital wallet. Moovel even offers the possibility to cancel a booking or a reservation in the app. To be sure, all invoices from the different partners will be received per email, after the transport service has been used. Moreover, each customer has an own PIN-Code, which is used to confirm bookings and payments, but also to access booked cars or Bikes. (Moovel Group 2017-1)

Basically, the moovel app is available worldwide However, there are still some constraints. Ticketing integration isn´t yet developed among the different transport modes, and booking functionality is currently only available in Germany. Yet, even though car2go and NextBike accounts need to be linked to Moovel directly by the customer, an extended ICT integration is available for these partners. (Moovel Group 2017-1 & UCL London Institute 2015, S.17)

To enable users to access an urban mobility network anytime, anywhere, The Moovel Group has extended its mobility offer to the Messenger services of Facebook and Slack. Get an overview of nearby stops as well as information such as connections and departures for an ever increasing number of cities world-wide, as well as the availability and location of car2go vehicles, and a further linkage to the providers app. (Moovel Group 2017-2)

Moreover, Moovel supports the city council of Stuttgart (Germany) with a price campaign during days with particulate matter alert, in order to incentivize customers not to use the car in the urban area and to get on public transport. On days with very poorly exchangeable weather

conditions, Moovel offers, in cooperation with the VVS (*Transport Association of Stuttgart*), 50% off the regular VVS ticket prices in the whole VVS transport-area. Customers even have the opportunity to ride by bus and train for free. Right after the ticket purchase, a random generator decides whether a booking was free of charge, informing the customer via a push notification. (Moovel Group 2017-3)

Especially in these periods, it has been noticed that the number of VVS tickets booked through the moovel app was several times higher in the respective periods than on comparable weekdays without a fine dust alarm. Thus the expected load with fine dust and nitrogen dioxides is to be reduced. (Moovel Group 2017-3)

6.2.2 Qixxit, Germany

Qixxit, a multimodal information service operated by the German Railways Association *Deutsche Bahn*, offers a that connects digital offerings and mobility services on a virtual level on an common information platform, which provides direct and easy access to transport and mobility offers. (QT Mobilitätsservice 2017-3)

In contrast to other MaaS concepts, Qixxit integrates almost all transports and / or mobility offers, which are currently available in Germany. Even if *DeutscheBahn* is the incumbent railway operator in Germany, the company emphasizes, however, that the app is the neutral among all means of transport and, according to the user, the most favorable or fastest connections out. (König et al., 2017, p.23)

At present, more than 15 means of transportation are available from numerous partners. In addition to public transport, the local and long-distance transport of *Deutsche Bahn*, car sharing, car rental and bike sharing, the integrated transport services also include long-distance buses, carpooling and a partnership with suppliers of flights-tickets. (QT Mobilitätsservice 2017-2)

Especially long-distance buses were initially not planned to this extent, but it is stated that the customer needs have changed considerably. Further, the company has been integrating Europe's largest taxi booking portal (Taxi.eu), as well as carpooling opportunities (such as Blablacar). In addition, Qixxit does not only include public transport, but also takes into account the use of the own bicycle or the own car, and supports the driver with a parking routing. (QT Mobilitätsservice 2017-2)

Qixxit is described as a personal mobility advisor, which simplifies the complexity of mobility and shows the many ways of getting from A to B in a convenient way. It is possible to search, compare and combine different means of transport and thus to select the most suitable connection directly from door to door. Based on the user´s preferences and needs, Qixxit combines the variety of transport modes and shows the different ways to reach the destination. The overview shows all possibilities with the most important price data, such as price, duration, distance etc. (QT Mobilitätsservice 2017-3)

Further, Qixxit offers an easy personalization, by adjusting travel preferences and the settings for the means of transport and optimize the route search. The user can define his preferred means of transport, take into account own bicycle or car s or indicate the possession of a driving license. Further, it is even possible to specify the running speed in order to adjust the time computation for the walking distance. (QT Mobilitätsservice 2017-3)

The app includes an interactive map view, which shows quickly and clearly, where the next stop or the next car sharing station is located and how best to get around. It is also possible to display the type of transport used, and even to see the current traffic flow. Also, Qixxit provides real-time information about changes, delays, connections and connections on-the-go. The app shows platforms, flight numbers, or directions - and will take the user safely to your next point by pedestrian routing. With the help of the real-time vehicle data of the DB as well as extensive traffic information for the road, Qixxit is in a position to react quickly to faults and to determine efficient connection alternatives. (QT Mobilitätsservice 2017-3)

Yet, booking, ticketing and payment are only available for Railway- tickets of the operator *DeutscheBahn*. The app stores these as online tickets and offers access at any time. With the quick booking, tickets can be ordered with just one click, as customer and advantage cards (for example BahnCard) as well as preferred payment methods are simply stored in the personalized area. (QT Mobilitätsservice 2017-3) The purchase and payment of tickets for other transport modes is not yet available within the app, but has to be done within the ICT Integration of the transport providers. Currently, for example, the app links to the booking pages of the partners for taxis and car rental. However is expected that from 2017 it will be possible to book and book tickets for complete travel chains directly in the app. (Wölbert 2016, n.pag.)

6.2.3 iDPass, France

SNCF is France's national state-owned railway company, has created several new multimodal services and service combinations. The goal of the development of more integrated, multimodal services is to increase the modal-split share of trains and to attract new customers, which has been successful. The value proposition for customers is improved customer relations and integrated services. The idea of mobility services is to offer door-to-door services and to develop first and last mile transportation. Further, the aim is to integrate these mobility offers to global service platforms with access to all services. (König et.al. 2016, S.23f & SNCF Mobilite 2017-1)

At each reservation, the price of the service is presented in advance on the iDPASS application. The ***iD-PASS*** is a mobile application for door-to-door transportation planning, including proposals for services for the first and last mile. iDPass inlcudes a single, common interface to facilitate travel journey planning, to facilitate the planning and organizing of the entire trip. The service includes (König et.al. 2016, S.23f & SNCF Mobilite 2017-1 & SNCF Mobilite 2017-2):

- **iD-CAB**, a taxi or car-with-a-driver service with fixed price and advance payment. The reservation can be done in the web site iDCAB or using the iDPASS-application.
- **Wattmobile**, a self-service rental service for electric vehicles (tow-seater Renault Twizzy and scooters). The service is available at 11 railway stations. The iD-Pass card with RFID can be used to start the vehicle.
- **Zip-Car**, a self-service car-rental / -sharing service, is available in Paris and in a few other locations, and is about to expand. The car can be opened by using a smartphone with the iD-Pass application.
- **Bicycles:** the application shows the locations of self-service bicycle stations and the number of available bicycles.
- ***Parking places***: the application visualizes the parking places available nearby. By clicking on a parking place, the application shows name, address and opening hours of the parking place. The application also shows the route to the parking place.

The terms of payment vary, based on the service offered by iDPass and used by the customer. While the services provided by iDCAB are payable with each transaction, directly on the iDPASS application, the services provided by Zipcar and Wattmobile are invoiced at the end of the month, depending on usage, on the bank account filled in at the time of registration. (König et.al. 2016, S.23f & SNCF Mobilite 2017-1)

Furthermore, SNCF has created several other applications and mobility services, in order to respond to different customer expectations. There are also (König et.al. 2016, S.23f):

- **iD-VROOM**, a car pooling service. Regular users have a guaranteed return journey by taxi if the driver unexpectedly cannot bring one back. iDV-Room users have also a free automatic toll badge, no management costs, and receive a monthly invoice, which can be downloaded in the application. (König et.al. 2016, S.23f)
- **iD-AVIS** service allows to book a rental car and train ticket simultaneously. iD-AVIS gives reduced prices which vary depending on if the user has a SNCF discount or loyalty card. The service is available at over 170 railway stations in France and over 90 stations in Europe.

For students, a dedicated service names “Pack Mobilité” (Mobility Package) has been launched in 20 cities and the aim is to have all university cities included. The services included and prices vary as they are agreed with local actors. “Pack Mobilité” services include local trains, metro, bicycle, car-pooling, car-sharing and discounts for long-distance trains. (SNCF Mobilite 2017-3)

7. RESULTS

The survey results focusing on international MaaS concepts have shown that currently, there exist especially smaller MaaS-pilots that cover different geographical service areas, for instance cities as well as rural and / or regional areas. Only very few larger MaaS services have been established with a wider geographical coverage, and are not yet including mobility packages of a larger scale. In fact, there aren´t any integrated mobility conceptions that include national and international service coverage.

Out of all the analyzed pilots, the regional public transport provider can be seen as one of the core elements, integrating car-sharing and bike-sharing companies as well as integrated taxi or other demand-responsive mobility services. Thus, this shows the importance of the complementary role of shared mobility to provide a flexible and subsidiary mobility offer, offering a viable alternative to the usage of private cars.

Just as important is the advanced integration of multimodal information planning, as well as ticketing and payment functions. Especially the access of users to real-time traffic information and an integrated journey planning tool seems to be really considered as a basic element for the deployment of seamless mobility offers. Not yet completed is the integration of incentives to motivate the consumers to travel in the most green and sustainable way; for example, eco-friendly trips are proposed on the multimodal platforms of Smile or Moovel, and even rewarded in the Whim-Concept. Moreover, the importance of ticketing and payment integration seems to be understood, since there is in the most cases the possibility to pay for the services booked and used in one single account. Even if some of the concepts still refer to a link of the transport provider´s app in order to book and pay for the service, a strong will to extend the platform integration to an integrated payment solution seems to be vital in every conception.

It has to be mentioned that the availability of user-specific mobility packages as the most essential characteristic of fully-integrated MaaS, has not yet been deployed in all its opportunities. Only MaaS Global´s Whim and the 6 month-pilot of UbiGo did include mobility packages that have been tailored to the user-specific needs of different target groups. Beyond that, only Hannovermobil offers a kind of a mobility package too. Yet, üstra´s mobility package is a single package with a fixed monthly fee, which is not based on specific customer groups, but offers the possibility for the user to include the services they prefer or need. The other investigated integrated mobility solutions do not offer these varieties of mobility packages and fees, but “only” offer the pay-as-you-go option, which are paid before or after the transport or mobility service has been used.

Finally, the integration of electric mobility and the designs or conceptions for autonomous driving is not yet available, planned or explicitly mentioned across the different cases. Only the more developed MaaS approaches in Finland, such as Whim and Tuup, have been experimenting or are planning to launch pilots on autonomous car or shuttle services.

		Whim	Tuup	Ubi.Go	Smile	Hannover-mobil	Moovel	Qixxit	iDPass
Multimodal Plattform	**Journey Planner**	x	x	x	x	x	x	x	x
	Real-Time Information	x	x	x	x	x	x	x	x
	Sustainability	x			x		x		
One-Stop-Shop	**Booking**	x	x	x	x	x	x	x	x
	Ticketing	x	x	x	x	x	*	**	x
	Payment	x	x	x	x	x	*	**	x
	Discounts	x		x		x	x	x	x
Payment	**Mobility Packages**	x		x		x			***
	Pay-as-you-go	x	x	x	x	x	x	x	x
Combined Mobility	**Public Transport**	x	x	x	x	x	x	x	x
	Shared Mobility	x	x	x	x	x	x	x	x
	E-Mobility			x	x				x
	Autonomous Driving	Pilots	Pilots 2017						
Other Services	**Parking**	x			x				
	Delivery			x					

*restricted, only in Germany

** restricted, expected to be fully integrated in 2017

*** special offers for youngsters and adults

In the second part of the analysis, it was initially planned to examine and demonstrate the effects of the MaaS concepts on the derived (traffic) policy objectives by using quantitative dimensions on the basis of the selected indicators.

However, because of different obstacles, it was ultimately not possible to carry out this quantitative assessment in the approach. This is due to the fact that the MaaS concept, as already mentioned, is still very new, and the current projects, which are aiming at the implementation of fully integrated mobility concepts in the sense of the Mobility as a Service vision, still feel themselves in test phases or pilot projects. Only a few surveys on the effects of the MaaS concepts have been collected so far in a few projects after the first test phases. This is why only the following tables cannot be filled with empirical data to conduct the intended research. Yet, the indicators still can be used in further researches, by gathering the data that is needed to fulfill an evaluation of the effects and changes that can be noticed by comparing the situation before and after the implementation of a MaaS within a certain geographical area.

So far, it can only be referred to the little information given by the statements of the UbiGo-Authorities (UbiGo 2013, n.pag.) and the Smile Project in Vienna (Smile Mobility 2015-2, n.pag.), who indicate some positive results that have been achieved through the extensive tests during their pilot operations. Ultimately, even these projects didn´t publish the empirical data that would be needed to fulfill the envisaged evaluation of the impacts of MaaS. At least, the short evaluations that have been found about the projects in Gothenburg and Vienna emphasized that the pilots did lead to highly positive results.

For the UbiGo-Pilot is has been concluded that the project has proven the concept of Mobility as a Service in reality, and that the households that have taken part in the trial wanted to continue using the mobility service in form of mobility packages. Just as well, the pilot has contributed to a change in the mobility behavior of the households, by offering easier access to more modes of travel. (UbiGo 2013, n.pag.)

For the Smile Project, it has been stated that the usage of the mobility platform increased the choice of intermodal trips of the users, especially by suggesting quicker alternatives by displaying the possibilities to combine public transportation with private cars, bikes or shared transport modes. Further, the choice of transportation modes has been influenced, by showing new transport modes and proposing alternative routes, which are more efficient, environmental friendly and attractive in comparison to the usual travel habits of the users. Moreover, the citizens increased the usage of sharing offers and e-mobility and at the same time reduced the occasions when they used their private cars. (Smile Mobility 2015, n.pag.)

In fact, this shows the potential of Mobility as a Service to have positive impacts on the achievement of goals and objectives of transport policy and other mobility related conceptions. However, it becomes clear that the accessible, available data deal primarily with the changes in the mobility behavior and do not go beyond it. In addition, the analysis of the Smile projects´ survey only provides information on the proportion of respondents who have undergone behavioral changes; a quantitative before-and-after comparison is, however, not possible here. As a result, it is important to note that both the evaluation of the projects

currently does not provide sufficient quantitative data needed for the assessment based on the selected indicators. Ultimately, it is not possible to measure the actual impacts of Mobility as a Service on potential transport policy objectives even in the approach, and therefore also quantitatively.

Transport Policy

Objective	Indicator	MaaS-Concept	
		Before Implementation	After Implementation
Improve Efficiency of allocation of Resources	Net Public Finance		
Reduction of traffic volume and (urban) congestion	Motorized Traffic densities, during peak-hours and off-peak		
	Commuting Time		
Reduction of car-ownership	Motorization Rate		
Increase the attractiveness of public transport, walking and cycling	Modal Split in Passenger Transport		
	Average distance covered by car		
	Availability of intermodal connections		
	Transport Demand		
	Opportunities for Active Mobility		
	Average distance covered by eco-friendly transport modes (PT, Bike, Foot)		
	Physical and Mental Comfort of Citizens while using public transport services		
	Satisfaction with Public Transport		
	Satisfaction with pavements and footways for pedestrians		
	Satisfaction with cycling path network		
	Use of alternative Mobility offers		
Improve Level of Service of Public Transport	Share of Public Transport of motorized transport during peak-hours		
	Transport Capacity during peak-hours		
	Public Transport Service		
	Public Transport Reliability		
	Average Travel Speed of Public Transport		

Increase of Efficiency of Use of Transport Capacities	Occupancy Rate		

Table 1: Evaluation of the impacts of MaaS on Transport Policy

Environment

Objective	Indicator	MaaS-Concept	
		Before Implementation	**After Implementation**
Reduction of environmental impacts of transport sector	Emissions of Greenhouse gas		
	Traffic Noise Hindrance		
	Energy Efficency		
Encouragement of a more sustainable mobility behavior	Active Mobility		
	Car-Use		
	Bike Ownership		
	Modal-Split of Passenger Transport		
	Multimodality		
	Intermodality		

Table 2: Evaluation of the impacts of MaaS on Environmental Goals

Society

Objective	Indicator	MaaS-Concept	
		Before Implementation	**After Implementation**
More Affordable and flexible mobility for citizens	Affordability of public transport for the poorest group		
	Average Expenditures of Citizens for (individual) mobility consumption		
Improve Accessibility and Reachability of Districts and (Rural) Areas	Reachability of POIs		
	Accessibility for (deficiency) groups to transport and mobility services		
	Access to public transport		
	Access to car-sharing		
	Access to bike-sharing		
	Access to Mobility Services		

Table 3: Evaluation of the Impacts of MaaS on Societal Goals

Economics

Objective	Indicator	MaaS-Concept	
		Before Implementation	After Implementation
Generation of Jobs and Economic Growth	Degree of Accessibility to Job Market and Education System		
Making places more attractive to live, work and invest in	Quality of Transport Network Business Owners		
	Quality of Transport Network Business Citizens		
	Share of Spaces for cycling, walking and public transport		
	Share of Spaces for Parking Areas		
	Mobility Space Use		
	Fatalities by road and rail transport accidents		
	Quality of Public Area - Presence of attractive areas such as pedestrian street or squares which facilitate social activities and encourage citizen´s interaction		

Table 4: Evaluation of the Impacts of MaaS on Economical Goals

Finally, it has to be mentioned that both the timeframe and the personnel limits set this approach. On the one hand, since the approach or the focus of the work could not be changed because of the limited time, and on the other hand, since the data hasn´t either been collected or there is no access to the required information within the master thesis. Therefore it is being aimed to react as best as possible to these restrictions. Furthermore the proposal of the objectives that are derived from the benefits, which are to be expected from the implementation of Mobility as a Service at several levels, as well as the indicators proposed for the assessment of these impacts, are intended to be used in further in-depth analyses and researches to find out the actual impacts of MaaS. This is explained in detail in the last chapter (Further Research).

8. FURTHER RESEARCH

The survey showed that there are many different small pilots of which some have already established larger service integration and proven the viability of MaaS as a concept. These various cases show that MaaS is feasible at least on a local or national level. Yet, there are still hardly any international MaaS (related) services available providing integrated mobility solutions at least on a cross-border level. With this respect MaaS is currently more a regional or national mobility service phenomenon, although it can be expected that MaaS will be expanded internationally in the near future. (König 2016, S.55)

It is highly likely that the MaaS offerings will initially be designed and implemented within urban environments since the latter are subject to a set of mobility challenges, driven by new forces for change (e.g. overcrowding, congestion, pollution) and represent the economies of scale needed for a viable implementation, whereby MaaS can be connected to existing Public Transport Networks and their user-base.

Overall it can be noticed that MaaS is expected to have the potential to lead to major changes in the mobility behavior of citizens, offering various alternatives to the use of the (private) car, and thus a similar level of flexibility in an integrated, multimodal journey planning. It will be much easier for people to reconsider their travel (mode) choices, using sustainable and more eco-friendly travel modes and choosing the most convenient trip without being bound to the car. Further, considering the numerous benefits that are mentioned, MaaS can be an important instrument to support the achievement of political commitments.

However, if MaaS is to fulfil transport policy objectives, it is necessary to design networks in different geographical and institutional contexts. In other words, the coverage of MaaS must grow over time by connecting new geographical locations and transport modes. In practice, this necessitates multi-stakeholder approaches that can overcome different barriers and obstacles to integration, thus increasing the complexity to scale up the MaaS approach to larger geographical extents, including a much bigger number of stakeholders that have to be involved. (Holmberg et.al. 2015, S.43)

As MaaS is still emerging, there is going to be the need of empirical evidence bases in order to understand and to validate the expectation of transport customers as well as the potential impacts of MaaS. As mentioned in the chapter before, the investigated cases did not have quantitative data available or was not freely accessible since the initiatives are currently on test levels. Therefore the significance of the final assessment of the importance of MaaS is somewhat weakened for the strategic objectives of the transport policy. Even if qualitative conclusions suggest that MaaS can be highly effective, the application of quantitative results, analyzed on different MaaS projects covering various geographical areas, is highly important for the evaluation of the impact of MaaS and would significantly increase the meaning of MaaS as an instrument for transport policy.

In order to investigate and better understand the actual impact of MaaS, it will be necessary to collect quantitative data in the future on the basis of established indicators and then to carry out a monitoring of the effects of MaaS on the transport policy objectives. Therefore, more

pilots and live trials are needed to gather empirical data that is needed both to further evaluate the concept and to see large-scale effects of how different MaaS-designs affect the political, social or environmental issues.

Therefore, trends in mobility demand, changes in mobility behavior and the following impacts of the concept should been examined in more depth. In order to analyze citizens´ reactions, and the potential effects it will have on transport policy, a more profound and detailed survey needs to be conducted collecting the needed quantitative data to measure and evaluate developments and tendencies.

Due to the short time scale of the work and the absence of available data, it was not yet possible to conduct such an evaluation of the potential impacts of Mobility as a Service, except for the expected benefits that have been mentioned in different literature sources. As it will be necessary to evaluate and prove the impacts, based on the potential benefits of the concept, measurable data has to be investigated during pilots, live trials or launched MaaS-Concepts. However, this would take up a certain time to elaborate questionnaires or to prepare other methods of collecting data, to carry out the survey(s), collect and process the data and validate the data for a further evaluation. In addition, such a survey delivering the necessary information on demand, preferences, behavior changes or impacts could also play an essential role in understanding and determining the exact conditions and details of an optimal package design as well as the transport mode changes it would result in. (UCL London Institute 2015, S.79)

It is important to ensure that transport policy objectives etc. are subject to different challenges, depending on the situation and objectives of cities in strategic programs, or have to be adapted to the respective context. Therefore, the objectives and indicators defined in the work should be seen as a proposal or a possible basis of work, rather than as a general framework to gain an initial insight into how the importance of the MaaS concept can be assessed and assessed for transport policy objectives.

Therefore, it should be noted that the indicators chosen for the evaluation do not claim to be complete. If the indicators are used as a basis for a subsequent quantitative assessment of the impact of MaaS on transport policy objectives, it should be possible to change the selection of the individual indicators according to the requirements and expectations of the survey and to adapt them to the needs of the analysis.

It should also be pointed out that the importance of and for delivery and transport services, which have not been taken into account in the work, must also be considered in the long term. It is to be assumed that MaaS will not only have an impact on passenger transport objectives, but will also have an impact on traffic and on transport, which is important in terms of transport policy. It seems to be evident that there can be a close link between the mobility of people and the transportation of goods. Thereby research should be conducted on how to integrate and involve freight-related stakeholders in future MaaS services, in order to efficiently combine both passenger and delivery / freight within an integrated mobility service.

9. SUMMARY AND CONCLUSION

Mobility is an integral part of our society, with the Automobile as one of the main key enablers. This freedom of mobility is, however, at a price, since the growing traffic leads to gridlocks and has a higher environmental impact, such as the sealing of large areas or CO2 emissions. In addition, noise and fine dust pollution affect environmental quality.

As more and more cities are affected by the negative impacts of the rapidly increasing car traffic, decision-makers worldwide are looking for new solutions to tackle these problems. Municipalities and traffic planners are clearly narrowed down in this respect, as creation of additional infrastructures is often slow and expensive will not be the solution to the urban traffic problems.

The way we move around within our cities is about to undergo far-reaching changes. Different trends, recognizable worldwide, are influencing current mobility habits and conventions, thus shaping the society and their mobility needs of the future, having strong effects on many levels of our society.

Urbanization and the rising population lead to a growing number of people living in urban areas and being dependent on private cars. The rising demand for mobility, places intense pressures on city resources and infrastructure. Congestion is already close to unbearable in many cities, and concerns about transportation as one of the leading contributors to global greenhouse gas emissions, congestion, noise and poor air quality in cities rise.

In addition, social changes, referring to an ageing population as well as to profound changes in people´s mindsets, are coming up, setting new challenges for the mobility of the future. Just as that, environmental targets put pressure on a more sustainable development of transport and mobility issues. Further, the poor availability of funding requires States and municipalities to increase in the efficiency of operations, and to rethink the approaches to provide affordable mobility to the citizens.

In fact, the Focus of Political Agendas are shifting, increasingly reflecting concerns about air quality, physical health and wellbeing. Governments are actively developing mobility policies to favor active modes, encouraging citizens to walk and cycle more. There is a clear trend towards a more intense use of public-transit, cycling and walking.

As more of the world’s cities are facing these mobility challenges, the transport sector is at the beginning of a significant disruption, as new trends are starting to change behaviors and attitudes, leading to new opportunities to solve the mobility challenge. These trends incorporate the changing society and represent a new way of thinking.

The uptake of the sharing economy and technological innovations are opening up a new space for market entry, enabling a different and more widespread consumption of Mobility. Today, the transport sector is being opened up by a myriad of start-up companies exploiting new potentials and disrupting long-established companies and practices. Car-sharing-, Ride-hailing- or On-Demand-Shuttles services innovative new products and services, making transportation will become more multimodal, on-demand and shared.

This leads to a new way of thinking of the society as well as in the planning and organization of mobility. Transport Sector is re-defining itself, providing the means to a more flexible mobility. The focus is shifting, from solely providing (urban) transport networks (i.e. buses, trams, trains or infrastructures) to what mobility actually means, focusing on what people require and where the supply is needed. More modes will be considered as an integral part of an integrated transport network. As alternative mobility services start to expand, traditional transport modes (such as bus, train or tram) become more blurred.

Therefore, a clear shift towards an integrated, whole journey approach can be recognized. As current transport and mobility offer are very fragmented and impersonal, there is a value in bringing seamless integration to customers across their entire journey. With an integrated mobility approach available, mobility will be truly more of a service than a single transportation solution.

Within this new thinking, Mobility as a Service (MaaS) can be identified as one of the most promising concepts, coming about from a very real need for more efficient transport solutions. The Concept of Mobility as a Service is based on a specific mobility service that seamlessly combines various transport options together into a single intuitive mobile app. It combines options from different transport providers into a single mobile service, integrating the payment of services and trips, thus removing the hassle of planning and one-off payments.

The Idea is relatively simple, yet revolutionary: bundling different transport means, public and private, into easy-to-use packages for customers, offering different volumes of usage of various transport and mobility services. The packages would cover a range of fees from the different transport modes, and users wouldn’t need to manage multiple passes, fees, or payment modes. They will be charged per trip or a monthly fee for a limited distance. The monthly fees may vary depending on how much transportation is needed or for instance, based on time or comfort level.

However, Since Mobility as a Service is a relatively new concept, only a handful of pre-/case studies exist. This is why it is difficult to give clear interpretation of the term Mobility as a service, since a commonly agreed definition doesn´t exist yet. It appears to be difficult to completely discern which services concretely fall into the concept of MaaS. Therefore, it is useful to take a look at various approaches to explain and to define the scope of the term Mobility as a Service and to develop a clearer understanding of its main ideas.

The review of the different approaches and definitions of the concept allows to identify the important and crucial factors for MaaS, that have a high probability for being relevant more broadly for the Maas phenomena. Different components can be identified as integrated parts for the deployment of MaaS Concepts. These are Combined and Shared Mobility Modes, including Electrified and Autonomous Mobility Options, an Integrated Mobility Platform, including Multimodal Traveller Information as well as an integrated One-Stop-Shop, including the planning, ticketing and payment as well as the provision of Mobility Packages, and further special offers or discounts. A strong focus is placed especially on the integration of different transport modes with the aim to bring people to use more alternative transport modes instead of only using their own private cars.

Mobility as a Service is expected to lead to structural changes, involving a shift in transportation from a fragmented system of individual service providers and individual car ownership to an integrated, multimodal transportation system. The vision is to perceive the whole transport sector as a cooperative, interconnected ecosystem, seamlessly combining different transport services and reflecting the needs of customers.

Since the current organization of public transport provision does not sufficiently contribute to a functional and convenient mobility service ecosystem, it is being suggested to establish a renewed organizational framework, which is essential in order to reach efficiency gains and sustainability in mobility. This transformation stipulates “Mobility as a Service” as an additional level in the organization of the service provision. This MaaS-Level contains the provision of the services feature the user interface of the transport services. Further, this requires a re-organization of the current business structures, and thus the generation of mobility service operators as new actors in the ecosystem. Moreover, a revision of the purchase and subsidization procedures has to be elaborated in the transformation of the transport sector. Instead of having the subsidization and purchase of transport services by the governments and the municipalities, this task will be taken over by the Mobility Operator. All transportation is in the future offered and subsidized jointly trough the Maas level, from where the funds would be distributed to the other levels.

In order to establish a functional ecosystem, one of the most important factors will be getting all of the players to work together. This is essential for the sufficiency of the ecosystem, but also for the motivation of all the actors that have to be involved. In order to unfold and stimulate the impact of MaaS, an effective collaboration between different actors will be important. Thus, different authorities must be taken into account when proving both transport services and mobility services. While the Public Level will be in charge of setting the legislative and regulatory Framework, the main operators in the service mobility ecosystem will be the Transport and Data Providers and Mobility Operators.

The Mobility Service Operator combines the existing transport services into a single mobile application on the “one-stop-shop” principle and provides personalized transport plans tailored to the different customer needs. It is only uncertain which sector would be appropriate to fill the important integrative function of the mobility operator, and setting up and managing a mobility platform. On the one hand, Transport Service Operators, regional transport agencies and other incumbent transport operators, since they already organize and manage multiple public transport modes, and thus dispose over the necessary experiences, a ready-made broad customer basis as well as intense linkages and access to other local stakeholders, politics, and the administration. On the other hand, there can be external, independent operators, such as car manufactures or actors that are completely outside the transport sector, such as telecommunication providers, software companies (e.g. Google, Apple) or even retail companies.

Since Mobility as a Service stands for a transition to a more significant service provision, focusing entirely on service distribution, it is expected to create a new model in how customers buy travel opportunities. Travel will be purchased using service contracts, and provided in packages rather than as individual services. This business model takes its

inspiration from the structural changes that have occurred in the telecommunications sector following its liberalization over the past several decades.

For the Providers and Operators, the business perspective is very present as well. The Enormous Market Potential of MaaS is expected to offer very significant business opportunities. Mobility operators will most likely change the logics of the rest of the value chain as they will make service provision a business, using service contracts and bilateral agreements with providers and customers. Further, it is expected that the generation of more than one operator may result in an increased competition, leading to prices that more accurately reflect operations costs, service improvements and efficiency gains.

What is the most important is that the survey results focusing on international MaaS concepts have shown that there currently exist especially smaller MaaS-pilots that cover different geographical service areas, for instance cities as well as rural and / or regional areas. Only very few larger MaaS services have been established with a wider geographical coverage, and are yet not including mobility packages of a larger scale.

The analysis of the potential outputs of shows that Mobility as a Service is expected to provide manifold benefits for both, the users, the public sector as well as for the business sector. It is supposed that if the concept of Mobility as a Service can potentially help to bring about beneficial behavior changes, then it can also potentially support wider social, economic and environmental issues. In order to be able to better define the scope of political decisions on the transport sector and mobility options of the future, a clear political commitment of the transport policy is required. It will be important to anchor MaaS directly and purposefully as a political objective in strategic programs and to prepare suitable transport policy strategies.

In the second part of the analysis, it was initially planned to examine and demonstrate the effects of the MaaS concepts on the derived (traffic) policy objectives by using quantitative dimensions on the basis of the selected indicators. However, because of different obstacles, it was ultimately not possible to carry out this quantitative assessment in the approach. Due to the fact that the MaaS concept is still in a very early state, the current projects, which are aiming at the implementation of fully integrated mobility concepts in the sense of the Mobility as a Service vision, still are in test phases or pilot projects. This is why only a few empirical values on the influence of MaaS have been raised.

It became clear that the available data deal primarily with the changes in the mobility behavior and do not yet go beyond these topics. Ultimately, it was not yet possible to measure the actual impacts of Mobility as a Service on potential transport policy objectives, so that no quantitative evaluation could have been established. As MaaS is still emerging, there is going to be a need of more empirical evidence bases in order to understand and to validate the expectation of transport customers as well as the potential impacts of MaaS. To realize the full potential of the concept to provide sustainable impacts, a more extended survey has to be based in further approaches, by collecting quantitative data in future projects. These should be used pursue the attempted approach on the basis of the indicators that have been suggested, and monitor and evaluate the effects MaaS as an instrument of transport policy.

Nevertheless, considering the ideas respectively the vision of the concept of Mobility as a Service, it can be expected that MaaS will have enormous potential to revolutionize the transport sector and to induce important changes on a long-term plan. This can be illustrated by the various benefits that the deployment of the concept of the integrated mobility service is considered to bring about, be it for the citizens or the public sector. Due to the effects that the implementation of MaaS can have on issues that have been identified to be major challenges for (urban) mobility and transport systems, it can be derived that MaaS has the potential to become an important instrument for public authorities to support the achievement of goals and objectives of transport policy and closely related environmental, social or economical targets. However, the mentioned political commitment has a high relevance for the support and promotion of such an integrative mobility approach. Therefore, fixing MaaS as an important part of strategies and instruments for the achievement of long-term visions of transport policy has to be followed. However, even if the full impact of Mobility as a Service for objectives and strategies of transport policy has to be based on empirical evidence of measurable changes, the innovative concept of Mobility as a Service is a potential instrument for a more efficient and sustainable promotion of mobility in the future. Thus, MaaS can be of a high relevance for transport policy.

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